AUSTRALIAN METEOROLOGICAL OBSERVER'S HANDBOOK

1925.

OFFICIAL—NOT FOR SALE.

METEOROLOGY OF AUSTRALIA

COMMONWEALTH BUREAU OF METEOROLOGY

MELBOURNE.

Australian Meteorological Observer's Handbook

1925

Published by the Authority of the
Minister for Home and Territories under the Direction of

H. A. HUNT,
Commonwealth Meteorologist.

Wholly set up and printed in Australia.
Registered by the Postmaster-General for transmission through the post as a book.

By Authority:
H. J. GREEN, GOVERNMENT PRINTER, MELBOURNE.

C.3403.

PREFACE.

It is hoped that this work will meet a requirement of the Australian Meteorological Service, the fulfilment of which is long overdue.

The form of the volume is based to a very large extent on the *Observer's Handbook* of the London Meteorological Office, which has been very freely borrowed from. For some of the tables recourse has been had to the *International Meteorological Tables* and *Tables for the Reduction of Meteorological Observations in India*, 1910.

The compilation was entrusted to Capt. E. Kidson, O.B.E., D.Sc., F.Inst.P., and, with assistance from Mr. H. M. Treloar, B.Sc., and other members of the staff, has been carried out in a comprehensive and thorough manner.

There are many branches of meteorological investigation, such, for instance, as upper air observations, atmospheric electricity, solar radiation, &c., which cannot be covered in the present volume. Those interested are referred to the *Dictionary of Physics*, especially Vol. III., Meteorology, Metrology, &c., where they will find not only a series of excellent articles, but a very complete bibliography on many of the more advanced fields of experimental research.

H. A. HUNT,
Commonwealth Meteorologist.

19th February, 1925.

CONTENTS.

PART I.

Contents—Part I.—*continued.*

PART II.

SELF-RECORDING INSTRUMENTS.

PART III.

SUPPLEMENTARY INSTRUCTIONS, SPECIFICATIONS, ETC.

Contents—Part III.—*continued.*

PART IV.

METEOROLOGICAL TABLES.

Australian Meteorological Observer's Handbook.

PART I.

INTRODUCTION.

Reading of Instructions.

All observers are strongly urged, not only to read these instructions carefully, but to refresh their memories from time to time by a re-perusal of them. Various points to be remembered and precautions to be taken are liable to be forgotten in course of time, and the observer's methods to become slovenly in consequence, unless the above advice is followed. Furthermore, the information contained in the ensuing pages cannot be imparted in a few hasty verbal instructions. Personal instruction should, therefore, always be supplemented by a reading of the Handbook.

Importance of Reliability and Accuracy.

The importance of regularity, care, and accuracy in the taking of observations cannot be too strongly emphasized. He who faithfully carries out his duties each day is performing a valuable public service. The results derived from his records are constantly being consulted for information regarding climatic conditions by persons in practically every walk of life. The enumeration of the avenues of social and industrial activity in which climatological data are of importance would consume much space, and could never be complete, as fresh ones are continually being found. Among the more important, however, are agricultural and pastoral industries, public health, and scientific research. In the case of the introduction of the cotton industry into Australia, for instance, the first step was to discover, from their climatological characteristics, what places should be expected, in the light of experience elsewhere, to be suitable for its growth. Again, certain tropical diseases are found to be confined to places with rainfall above a certain limiting value. The medical organizations are thus forewarned as to the directions in which these diseases are likely to spread, as well as having information which may suggest modes of attack on them. In the securing of reliable observations, the Meteorological Bureau is largely in the hands of observers. Poor returns mean a great deal of extra work in the office in the checking and correction or rejection of faulty observations and

in endeavours to supply missing ones. No one of the various observations listed in the routine can be considered unimportant; each may be required for some special investigation. Unreliable observations are a permanent blemish on the records of a station, and observers can be sure that their sins in this direction will ultimately find them out. Unfortunately, no opportunity of rectifying them can occur. Nothing is so depressing or so calculated to waste the time of an investigator as unreliable records. The variations to be dealt with in comparing different seasons or places, or in other researches, are often very small, and any persistent error becomes important. As an example, it may be mentioned that close relationships have been shown to exist between the deviations from normal of the monthly mean pressure at Darwin and the seasons in the Dutch East Indies and Australia, yet these deviations extremely rarely exceed 0.05 inch.

Classification of Stations.

It is impossible for a meteorologist to understand the weather processes of his own country without studying those of the world in general. The task of correlating and comparing observations becomes extremely difficult, however, unless they are made on a uniform plan. To secure this required homogeneity of data, International Meteorological Conferences have made numerous conventions, providing standard methods of recording the quantities observed. Among these conventions was one established in Vienna in 1873, which divided stations into classes according to the observations it was possible to undertake at them, and prescribed, within limits, the equipment, and the routine to be followed. The Vienna scheme, with slight modifications to meet Australian conditions, is as follows:—

(1) **First Order Stations:** NORMAL METEOROLOGICAL OBSERVATORIES: at which continuous records of pressure, temperature, wind, sunshine, and rain, with eye observations at fixed hours of the amount, form, and motion of clouds and notes on the weather, are made.

(2) **Second Order Stations:** NORMAL CLIMATOLOGICAL STATIONS: at which are recorded daily, at not less than two fixed hours, observations of pressure, temperature, wind, cloud and weather, daily maximum and minimum temperatures, the daily rainfall, and remarks on the weather.

(3) **Third Order Stations:** AUXILIARY CLIMATOLOGICAL STATIONS: at which observations of the same kind as at the Normal Climatological Stations, but less complete or at different times, are taken.

(4) In Australia we have also **Fourth Order Stations**—RAIN STATIONS: at which are recorded the rainfall, amount of cloud, and the wind, the force of the last being determined by estimation.

Time.

Owing to the large range in longitude covered by Australia, different States make use of different Standard Times.

Meteorological observations are put to two main uses, namely, the preparation of the Daily Weather Chart, for forecasting and other purposes, and the preparation of climatological statistics. For the Weather Chart, simultaneity in the observations is the aim, the object being to obtain a comprehensive view of the conditions at some particular time, so that future developments may be predicted. In climatology, on the other hand, the daily variation of the different meteorological elements becomes important, and if observations are to be comparable they must be made at the same time of day for each station. The telegraphic reports for the Daily Chart are, therefore, made according to standard time, and the observations for climatological purposes according to local mean time.

Our time, of course, is derived from the earth's rotation, as indicated by the apparent motion of the sun. The interval between two successive crossings of the sun's centre over the meridian is a true solar day. Time based on the true solar day is called "apparent time". A sundial or a sunshine recorder, when correctly set, indicates local "apparent time".

"Apparent time" is, unfortunately, not suitable for general use, as the length of the true solar day is not constant throughout the year. To get over this difficulty, time is referred to an imaginary body called the "mean sun", which is supposed to revolve uniformly round the earth and complete each revolution in a time equal to the average length of the true solar day. Time derived from this "mean sun" is called "mean time".

Now, as the earth rotates from west to east, the sun appears to move from east to west, crossing the meridians of longitude at the rate of 4 minutes per degree, or 15 degrees per hour. It is thus apparent that each meridian will have its own time, which will be earlier than that for places to the west of it, and later than that for those to the east. The time of the particular meridian on which a station stands is called "local time", and it is local mean time on which climatogical observations are based.

It would obviously be inconvenient for each place to use its own local time for ordinary purposes, or the complicated machine of modern civilization would not function. Railway time-tables, for instance, would be a chaos. It is the custom, therefore, in civilized countries, to adopt certain "standard times". The standard world meridian is that of the Greenwich Observatory, and it is usual to adopt standard times which differ from Greenwich Mean Time by a number of even hours or half-hours. The standard time should not, of course, differ by too large an amount from the local mean time of any part of the area over which it is used. In Australia, the standard times are—

(1) For Western Australia—8 hours in advance of Greenwich, corresponding to the 120° E. meridian.

(2) For South Australia and the Northern Territory—9½ hours in advance of Greenwich, corresponding to the 142° 30′ E. meridian.

(3) For Queensland, New South Wales, Victoria, and Tasmania, and the Mandated Territories, the standard meridian is 150° E., and the time 10 hours ahead of Greenwich.

New Zealand time is 11½ hours fast, Fiji time 12 hours fast, and Samoa time 11½ hours slow on Greenwich.

A custom which is rapidly spreading, and which will probably soon become universal, is to number the hours continuously from midnight to midnight from 0 to 24. This obviates the necessity of indicating whether a time is a.m. or p.m., and prevents confusion arising from the omission of this distinction. It is also the usual custom to retain the same number of figures in designating the time. Thus 35 minutes past midnight is written 00.35 hours, 5 minutes past 7 a.m. as 07.05 hours, 2 p.m. as 14.00 hours. The retention of the four figures is useful for several reasons, one being that where times are listed in columns, it aids alignment. A possible development in the not distant future is the universal adoption of Greenwich Mean Time, to which there seems no valid objection.

Hours of Observations.

Observations for forecasting purposes are to be taken—

(*a*) In the eastern States, at 9 a.m. and 3 p.m. standard time (150° E.).

(*b*) In South Australia and the Northern Territory, at 8.30 a.m. and 3 p.m. standard time (142° 30′ E.).

(*c*) In Western Australia, at 8 a.m. and 3 p.m. standard time (120° E.).

At Auxiliary Climatological Stations and Rain Stations (3rd and 4th Order) observations are taken at 9 a.m. local mean time only; at Second Order Stations (normal climatological stations), for climatological purposes, at 9 a.m., 3 p.m., and 9 p.m. local mean time.

The latitude and longitude of a station can be read off a large scale map. The amount by which local mean time is ahead of Greenwich can then be found by dividing the longitude by 15. Thus, if the longitude of a station is 144° 15′ E., the local mean time is 9 hours 37 minutes fast on Greenwich. The station will be in one of the eastern States, whose time is 10 hours ahead of Greenwich. Local mean time will, therefore, be 23 minutes behind standard time, and the times for making climatological observations are 9.23 a.m. and 3.23 p.m., according to standard time.

The standard time corresponding to 9 a.m. local time is entered on the back of each Field Book before it is forwarded to a station.

Equipment of a Normal Climatological Station.

The equipment consists of the following instruments :—

Mercury barometer reading to .002 inch or .1 millibar.

Dry bulb thermometer
Wet bulb thermometer
Maximum thermometer
Minimum thermometer
} in Stevenson or other approved screen.

Rain gauge.

In addition, some stations are supplied with—

Sunshine recorder.
Solar maximum thermometer.
Grass minimum thermometer.
Wind vane.
Anemometer.
Evaporation tank.

Third Order Stations, in some cases, have maximum and minimum thermometers and rain gauge only, while Rainfall Stations have rain gauge or wind vane and rain gauge only.

Exposure of the Instruments.

The **barometer** is mounted indoors in as uniform a temperature as possible. It should be in a position where it is safe from rough usage, and where the illumination is good. Near a south window is a good position, as the barometer will not be affected by the direct rays of the sun, and the window usually provides a good background. Such things as fires and hot-water pipes are to be avoided. Provision must also be made for reading by suitable artificial light. *A match is not a good light*, owing to the smallness and variability of the flame. The height of the cistern of the barometer above sea level must be accurately known, and, once mounted, the barometer should not be moved. Should an emergency arise in which it becomes necessary to move it, the State Bureau should be immediately advised to that effect.

Thermometer Screen.—The object aimed at in fixing the exposure of thermometers is to have them record a temperature which is representative of the free air of the place near the ground, so that its temperature can be compared with that of other stations. This is a very important point to be borne in mind. Air near the ground usually mixes freely, and has a fairly uniform temperature, but if it is confined this is not so. Hence the best exposure is on a grass surface on an open unobstructed plain. Ideal conditions are not always obtainable; but the outdoor instruments should have an open grass space of not less than 30 feet by 20 feet. Bare ground and the walls of buildings radiate heat too freely, so that the temperature recorded in their neighbourhood is not truly representative of the free air. The screen and rain gauge should be not less than 10 feet apart. The distance from any object such as a tree or building should be at least twice the height of the object. The station

should be on generally level ground. A station on a steep slope or in a hollow is subject to exceptional meteorological conditions. In undulating country, for instance, even though the elevations are not great, the night minimum temperature is frequently several degrees lower in the hollows than elsewhere.

The accurate determination of the temperature of the air is a difficult problem in physics, owing to the air being at the same time a very bad conductor of heat and a very good transmitter of radiation. A body such as a thermometer suspended in the air, therefore, imparts heat to, or receives it from the air very slowly, and at the same time may be absorbing heat from, or radiating it to, its surroundings. This principle is frequently illustrated practically. Thus, in a cold room, a person may feel warm in front of a fire, but unless he be screened from radiation on the side away from it, he will be cold on that side and warm on the other. Being warmer than the walls of the room, he will radiate heat to them, but being colder than the fire, he will absorb heat from it on the side directed towards it. The difficulties of ascertaining the correct air temperature are attacked in two ways. Firstly, the thermometer is protected as far as possible from the radiation of surrounding bodies by the screen. Secondly, the poor conductivity of the air is largely counteracted by allowing it to stream freely past the thermometer. Large quantities of air are thus brought in contact with the bulb, and any difference of temperature is more speedily reduced. The screen is, therefore, designed so as to allow of a free circulation of the air through it, and is located in an open space so that it will be exposed to every breeze that blows.

The requirements of an observation site listed above should only be departed from where this is unavoidable, and after a full consideration of the conditions. Any departure from the requirements should be noted. It is to be remembered, also, that a once favorable site may be rendered unfavorable by the growth of trees or the erection of buildings. Any such adverse developments should be prevented where possible, and the Meteorological Bureau should always be notified of any change that has taken place. It is generally difficult and frequently impossible to obtain a satisfactory location near a city. In fact, the general temperature of a large city is greater than that of its surroundings. It is, therefore, all the more important that the greatest care should be exercised at country stations.

The bottom of the screen should be 3 ft. 6 in. above the ground. The door should open to the south, so that the sunlight shall not shine on the thermometers when it is open. The screen itself should be in the sun. It should be kept in good repair, and its surface white with paint.

There should be a space of at least 3 inches between the bulbs of the thermometers and the top, bottom, or sides of the screen. The thermometers should be so arranged that all parts of their scales over the range of temperatures met with can be read without the necessity of

moving any of them. The maximum and minimum should be sufficiently firmly clamped down to prevent their moving in strong winds, which might cause a displacement of their indices.

Rain Gauge.—The aim is to so place the rain gauge that it collects an amount of rain equal to the average fall over the surrounding area. That is, that the returns given by it should be representative of the district. The gauge is intended to measure all kinds of precipitation, including rain, dew, hail, or snow. The gauge used in Australia is, however, not suitable for regions of heavy snowfall. Gauges of special pattern are provided where snow has frequently to be measured.

The exposure of the rain gauge is an important, and often a difficult, matter. The gauge must not be sheltered from the rain by trees or buildings. On the other hand, the gauge itself disturbs the air flow in its neighbourhood to some extent.

The following rules are adapted from those of the British Rainfall Organization, and should be followed as far as practicable :—

(1) *Selection of Site.*—A rain gauge should be placed on a level piece of ground, not upon a slope or terrace, and certainly not on a wall or roof. Its distance from any object, including trees, buildings, scrub, vegetables, &c., should be at least twice the height of the object. Grass, &c., should be kept trimmed for at least 3 feet round the gauge. A site near trees and buildings should be avoided if possible, but low scrub, if at the distance specified, is rather an advantage, as it reduces the wind's velocity over the surface.

(2) *Mountain, Table-land, and other Especially Exposed Sites.*—Care should be taken in such sites that the gauge is not unduly exposed to the sweep of the wind. A level patch of ground, or a slight hollow, should be selected.

(3) *Placing the Gauge.*—The gauge should be planted in the earth fixed in a box (Fig. 1), or placed into a close-fitting hole in a block of cement. As it is occasionally necessary to remove the whole gauge from the ground, it cannot be permanently fixed. It should, however, fit fairly snugly in its case, so that it will not move when the funnel is being withdrawn or replaced, or when exposed to the strongest winds. A very careful watch should be kept to see that no leaks are developed in the gauge, that the top remains level, and the rim truly circular. The funnel should fit loosely on the gauge, so that no force is required to remove it. If it is at all stiff, the matter should be reported, and a new gauge will be sent. Three metal studs inserted on the sides of the gauge, near the top, support the funnel. The latter should rest squarely on these studs. The site should be well drained so that the gauge will not float in the accumulated water after heavy rains.

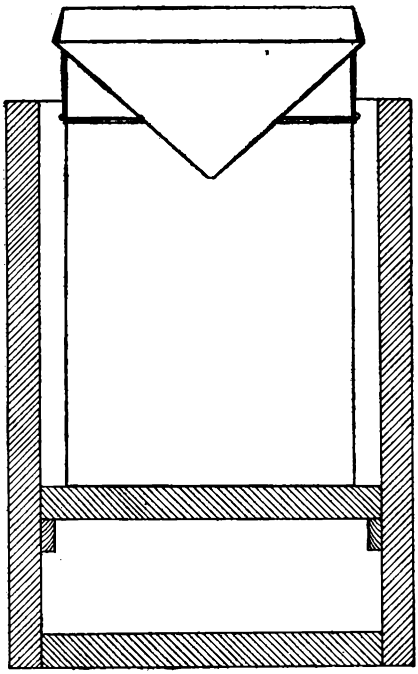


FIG. 1.

(4) *Height above Ground.*—The rim of the funnel should be exactly level, and at a height of 1 foot above ground.

(5) *Change of Site.*—Every effort should be made to maintain suitable conditions surrounding the site of the gauge. As long as this is done, no change should be made in the site. Even a small change may result in future records being non-comparable with previous ones, so that the continuity of the record is broken. Any change, however small, should be reported in detail immediately to the Central Bureau, giving date, distance, and direction from old site, &c. If a move becomes necessary, the best time to make it is on the first day of the year.

Evaporimeters.

Vessels or tanks used for determining the amount of evaporation should be exposed in as natural a way as possible. The conditions for a suitable site for a rain gauge hold, in general, for an evaporimeter also.

Observations of evaporation are of considerable importance for both practical and theoretical reasons. Any one, for instance, who requires to provide water storage or to construct irrigation channels should consider what loss will be caused by evaporation, and how this can be minimized. Men on the land frequently omit to make the simplest calculations with regard to these matters. It is useless to expect 3 feet of water in a dam to last throughout a dry summer if, as is the case over large areas in Australia, the evaporation during the summer months exceeds 3 feet. As a rule, more water is lost by evaporation from dams than is consumed by stock.

The evaporation from a water surface depends on (1) the amount of radiation received from the sun; (2) the humidity of the air; (3) the temperature of the air; and (4) the strength of the wind. The last two do not, as a rule, vary very much from year to year at a station, so that the difference between seasons depends largely on variations of the first two. The amount of radiation emitted by the sun fluctuates somewhat from time to time, e.g., during the sunspot period; but the quantity reaching the surface of the earth depends still more on the transparency of

the atmosphere. The latter will vary with the amount of moisture present at various levels. Thus the amount of evaporation will give an indication of the state of the atmosphere as regards vapour content. There is no doubt that an important characteristic of good seasons is the relatively large amount of moisture in the upper air. In drought seasons, on the other hand, the vapour content is low, and evaporation consequently at its maximum. Evaporation data will, therefore, be of value as an aid to the elucidation of the causes of seasonal variations.

Observers in the interior are, then, urged to give particular attention to the securing of satisfactory records from their evaporimeters. The water in the vessels should be kept at the correct height; the exposure should be free on all sides; and animals should be prevented from drinking the water. It may be necessary to build a stout fence with wire netting round the tank.

Site and Orientation.

The particulars required for the specification of the site of a meteorological station are its latitude and longitude and the height above mean sea level of the rain gauge and the cistern of the barometer.

The latitude and longitude can be scaled from a large scale map to the nearest minute, which is sufficiently accurate. Wherever possible, the height above sea level should be accurately determined by running a line of levels to the nearest "Bench Mark" or standard point, the height of which has been determined by Survey. At many places in Australia, however, the only means of determining the altitude is by a long series of barometer readings, the height being deduced from the actual reading of the barometer and the estimated sea-level reading as derived from the pressure chart.

The height of the station is generally regarded as the height of the rain gauge.

For various purposes it is necessary to have a meridian line laid down at a station, or to know the true bearing of some prominent object or objects. There are various ways of determining the local meridian. The best way, of course, is by astronomical observation with a theodolite or other instrument of precision. If this is not possible, one or other of the following approximate methods may be used:—

(a) By magnetic compass.—The prismatic compass may give a fairly accurate meridian if all precautions are taken. In the first place, it must have been ascertained by proper tests that the compass has no large error. Secondly, it must be remembered that the compass does not point due north, but at some angle east or west of it. This deviation from the true north is called by scientists the Magnetic Declination, and by mariners usually the Compass Variation. The approximate Variation for any station may be read off the isogonic chart on page 19. The value so obtained may however, differ by a degree or two, or, in cases where the

surrounding country is magnetically "disturbed", even more, from the true value for the station. The variation, then, having been determined as accurately as possible, the compass reading must be corrected for it, e.g., if the variation is 5° W., then the true north is 5° E. of compass north. When making an observation, care must be taken that the compass is not used in the neighbourhood of large masses of iron or strong electric currents. Iron at all near to it, such as keys or pocket knives carried by the observer, is especially to be guarded against. When once the true north and south line has been found, it is desirable to mark it down permanently.

(*b*) By the shadow method.—A narrow stake or rod is fixed vertically in the ground, and the position of the end of the shadow marked at a number of times near noon. The direction in which the shadow lies when it is longest is the true meridian. This method is not accurate when the sun is high at mid-day.

(*c*) In a region in which a detailed survey has been made, accurate bearings may be obtained from survey maps, e.g., the line of a street, the direction to a trig. station, &c.

The Specification of Direction.

Directions are specified in two main ways, first by the name of the point of the compass nearest to the direction required, second by stating the number of degrees and direction from one of the cardinal points. When expressing the direction in degrees, it is now becoming the universal custom to give it in degrees from north round by east through the whole 360°. The direction is then given in so many degrees without the need for further specification. Thus east =90°, south=180°, west =270°, and north=360°.

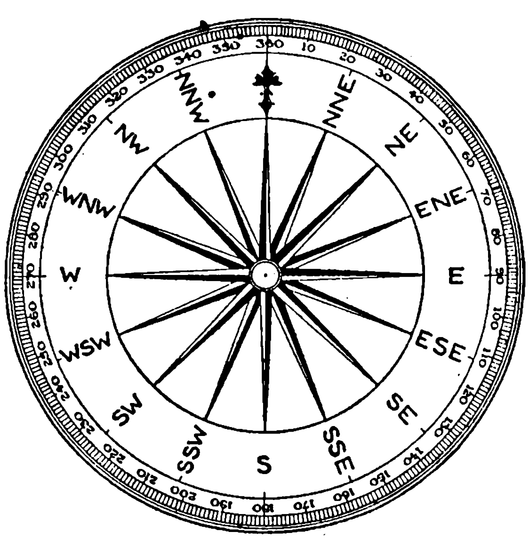


Fig. 2.

The points of the compass to 16 points are shown in the annexed diagram (Fig. 2). Without special means it is not usually possible to estimate the direction of wind or clouds nearer than to one of these 16 points.

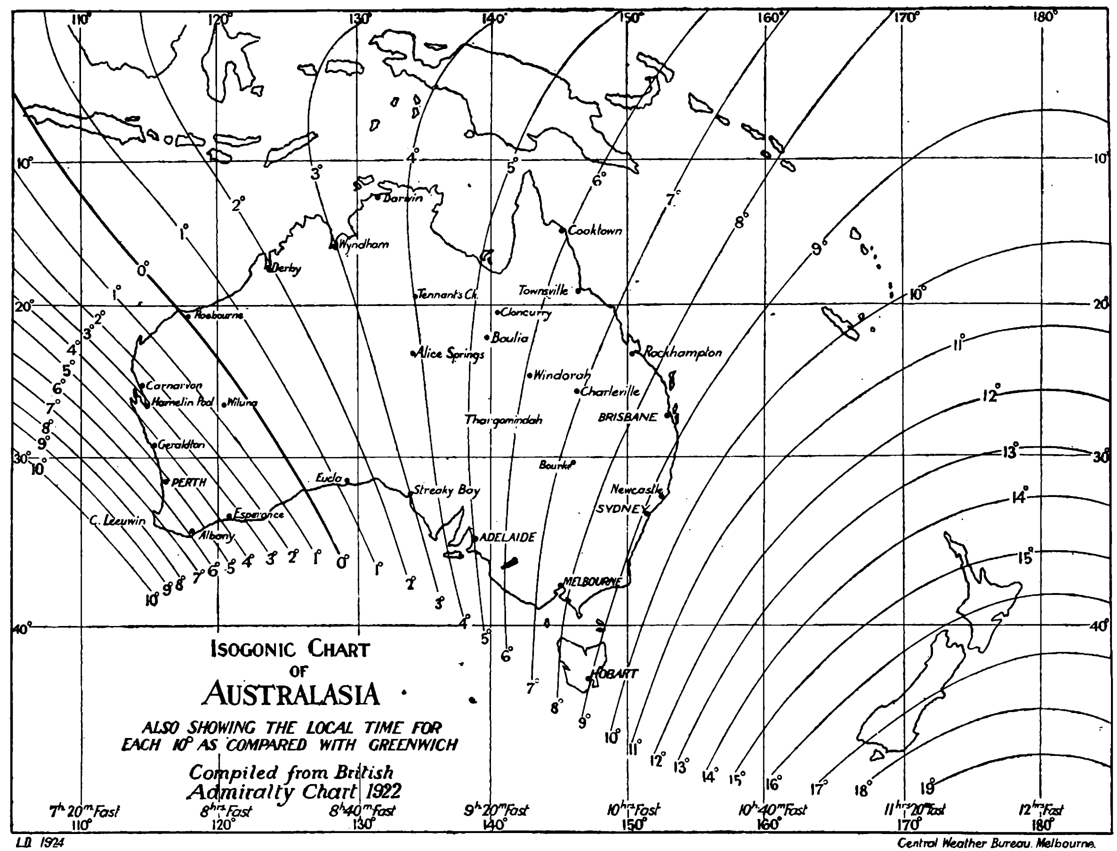


FIG. 3.

West of the line of no variation (the heavy line crossing Western Australia from Roebourne to the Bight) the variation is westerly and to the east of it easterly. Thus at Hobart the compass points 9° east of north, and at Perth 5° west of north.

Erecting the Wind Vane.

Owing to the expense involved, the Bureau is unable to supply many stations with anemometers, so that in most cases the force and direction of the wind has to be determined by estimation. The more important climatological stations are, however, provided with a wind vane to assist in the determination of the wind direction. The following instructions should be carried out in erecting and caring for the vane :—

(1) The vane must be freely exposed on all sides, and not affected by local eddies, &c.

(2) It should move freely.

(3) The cardinal points indicated on the vane should be correctly set.

The vane is packed in eight separate parts. The pedestal with centre bracket for the arms indicating the cardinal points, and also the bottom flange, are packed in one piece.

To erect the vane :—Fix the pedestal temporarily, and screw the arms into the centre bracket (Fig 4*b*) in the correct order, as indicated in Fig. 4*d* ; then screw on the lock nuts. Next put together the floater (Fig. 4, *a* and *c*), care being taken not to pinch the inner tube by screwing the arms in too far and so prevent free movement. Lock the arms by means of the nuts provided.

The arrow head is fixed in a horizontal position, being much easier to read so, especially at night, than if it were vertical (Fig. 4*a*).

The vane may be mounted on a stout post 10 feet or 12 feet high, either by screwing on by means of the flange or by removing the flange and wedging the pedestal firmly into a hole which has been bored vertically into the post for about 12 inches.

The true meridian having been determined by one of the methods described above, one or more of the cardinal directions should be laid out from the wind-vane post. The direction arms should then be accurately set. The positions of the pointers should frequently be examined and tested, as wooden posts are liable to warp and twist. Occasionally, too, strong winds will damage the arms or the vane.

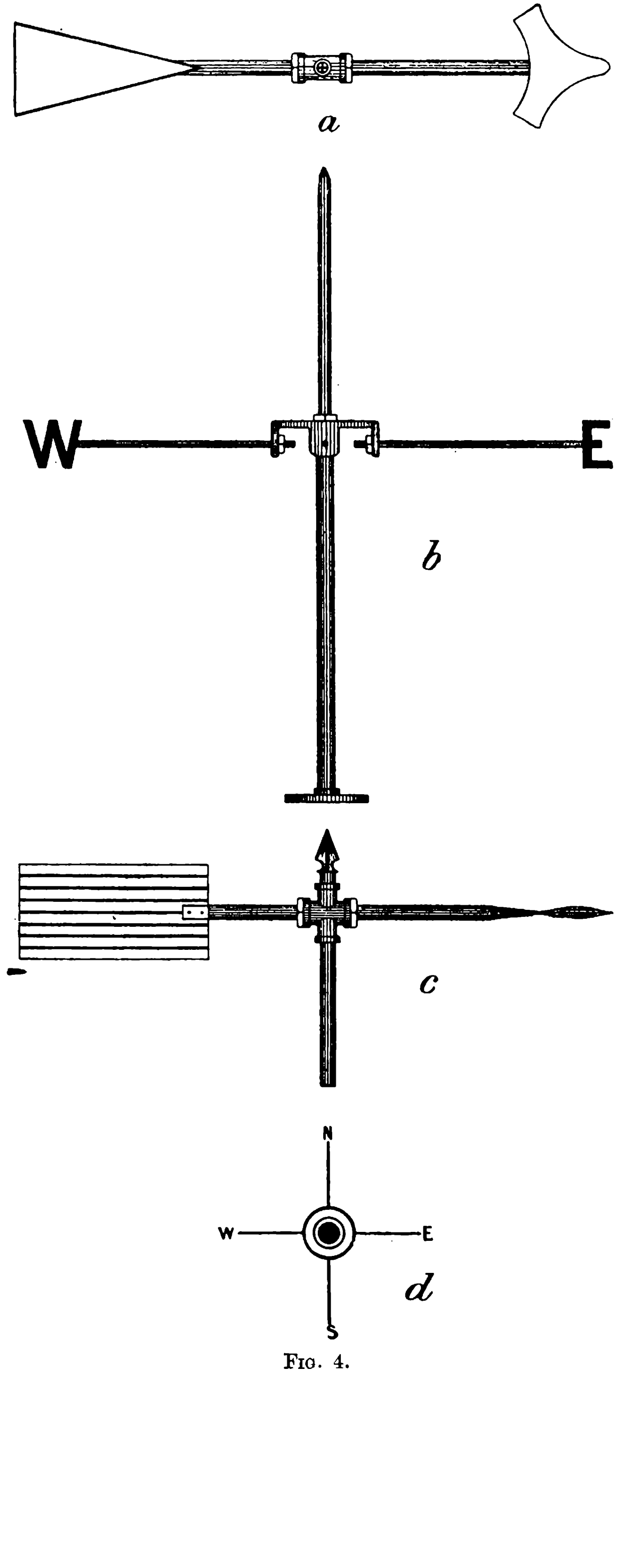


Fig. 4.

The Use and Reading of the Instruments.

The Mercury Barometer.

The barometer is an instrument for measuring the pressure of the air. The most obvious and convenient mode of determining this pressure is to measure the weight per unit area of the column of some convenient liquid which the pressure would support. Now, most liquids are so light that the column supported by the air pressure would be very high. For water, for instance, it would be about 30 feet, a fact which is made use of very frequently in pumping water from wells, the distance between pump and water being limited by the height to which the air pressure can force the water. In the case of mercury, owing to its great density, only about 30 inches can be supported by the air. Barometers were thus quite early constructed with mercury as the working liquid. The barometer really consists of a tube, sealed at the end, generally of glass, from which all the air has been pumped, and which is placed vertically with its open end dipping into a cistern containing mercury. If we consider the mercury at the level of the surface of the cistern, the pressure must be uniform throughout at this level. Otherwise mercury would either be forced up into the tube or fall down into the cistern. Now, the mercury in the cistern is subjected to the pressure of the superincumbent air, and that in the tube at the same level to the pressure due to the weight of the mercury in the tube above it. These two must, therefore, be equal. Thus the pressure of the air is determined if we can calculate the pressure of the mercury column. The pressure at the foot of this column on a surface of unit area is equal to the height of the column multiplied by the weight of the unit volume of mercury. Thus, as the air pressure varies, so will the height of the mercury column. Hence the custom arose of expressing the pressure of the air by naming the height of the column of mercury it would support, and barometers were graduated so as to measure this height. In English-speaking countries, consequently, the barometer reading came to be expressed in inches of mercury, and on the Continent and elsewhere in millimetres. That is, a pressure was expressed as a length, an obviously unscientific procedure. The only justification for the practice can be its convenience. The latter can, however, be very much exaggerated. It is never possible to make a direct accurate reading of a barometer with a scale, for two reasons: firstly, the weight of the mercury column will depend on the temperature, and, secondly, the graduations of the scale will also vary with the temperature. In order, therefore, to make readings which are comparable with one another, the readings of the scale must be corrected

for temperature, and so also must the measured height of the mercury. Furthermore, the weight of a column of mercury of given length varies with the latitude of the station owing to the variation of gravity. Again, the barometer reading will depend on the altitude of the station, so that to make readings from different stations comparable, it is necessary to reduce them to the same datum line, mean sea level being the one generally used. Thus, by the time all the corrections have been applied, we are a long way from the original measurement in inches or millimetres.

Many physical and chemical calculations involve the air pressure, and it becomes necessary to express it in force or pressure units. Now, science is international in its scope, and in order to make intercommunication as simple as possible, scientists have long found it necessary to use standard units. Those almost universally adopted are the centimetre for length, the gram for mass, and the second for time. The unit of force in this system is the dyne, and for pressure, the dyne per square centimetre. The force exerted by gravity on a mass of 1 gram in standard latitude at sea level is almost 981 dynes. A pressure of 1,000,000 dynes per square centimetre is equivalent to that of a column of mercury 29.531 inches high at zero centigrade and in latitude 45° at mean sea level. That is, 1,000,000 dynes, or the megadyne, is in the neighbourhood of the air pressures usually encountered on the surface of the earth, and consequently would make a convenient unit of air pressure. Chemists called the dyne per square centimetre a "bar", and 1,000,000 dynes would therefore be a megabar in their system. To meteorologists, however, it seemed more convenient to call the megadyne the "bar", as it represents approximately the pressure of one atmosphere. They then express atmospheric pressures in thousandths of a bar, or "millibars". The millibar is a convenient submultiple of the bar to use as a subsidiary unit, as ordinary day-to-day atmospheric changes usually amount to a few millibars. The millibar has, then, come to be almost generally used by meteorologists in Europe as the unit of pressure. Its use is continually extending, and there is every probability that it will become universal. There are especial advantages in the system for upper air calculations, which are now becoming so important in connexion with aviation.

The human race is very conservative, the British not less so than other members of it, so that it caused no surprise when the introduction of millibars was resisted, in some cases vehemently, by meteorologists of the old school. In England, the change was introduced in 1914, largely during the critical war period, when the number of persons who were forced to take an interest in meteorology was enormously increased. It was really astonishing how little difficulty this revolutionary reform occasioned, and how in a few months every one was thinking in millibars. If this was possible in England, the change should be easy in Australia, where the general standard of education is high, and where popular interest in meteorology is so keen. It is true that the advantages of the reform will be apparent, chiefly, to those only who have to carry

out investigations in the subject, but to them they will be very real. Nothing is more depressing than to have to take a large mass of figures and spend, perhaps, months in converting them to a common unit, when they could all have been so expressed originally without any additional labour. In Australia the question is not so important in connexion with the preparation of the daily weather chart and forecast as in Europe, but even here we have some ships using millibars and some inches, while reports from the Dutch East Indies and some of the French possessions in the Pacific require conversion before we can use them.

It is hoped, therefore, that it will be possible, ere long, to change from inches to millibars in Australia.

Illustrative of the illogicality of expressing pressure in terms of the length of a column of mercury is the sentence above giving the equivalent in inches of the megadyne. In order that the inch measurement may be precisely stated, it is necessary to prescribe the temperature of the column, the latitude, and the altitude at which it would be correct.

Types of Barometer.

The barometer in almost general use at present is the Kew pattern station barometer. At a few stations, the Fortin barometer, once more widely used, is still in service. The following instructions apply, especially, to the Kew type.

Transportation.

A barometer is a very delicate instrument, and must be handled with great care. It consists of a glass tube fixed by means of corks inside a brass tube. The great density of the mercury imposes a severe strain on the tube whenever the barometer is swung about in any way. Again, above the mercury in the tube there is, of course, a high vacuum. Therefore, if the mercury is allowed to run up to the end of the tube, as it will do if the barometer is tilted, it does not meet a cushion of air, but makes a sharp impact against the glass. If the tilt is sudden, therefore, the danger of fracturing is very great. Not only is there danger of breaking the glass if the barometer is roughly handled, but quite frequently air will be pumped into it even if the glass is not actually broken. The air not only throws out the reading of the barometer through the pressure it exerts in the tube, but also oxidizes the mercury, soon rendering the barometer useless. Once having been properly mounted by a responsible officer, the barometer should be moved only in case of serious emergency, such, for example, as fire. If it becomes necessary to move it, the instrument should be held steady in a vertical position while being released from its mountings, then slowly tilted until the mercury fills the tube, this being indicated by a sharp click as it reaches the top. It may then be placed in a case in a horizontal position, or carried inverted in the hand. In this condition, so long as it is not subjected to violent motion, the barometer may be transported with safety.

Mounting.

A suitable position having been selected (see above), screw the socket, which is now provided with all Kew pattern barometers, and which will be found in the case, to the support. Lift the barometer gently from the case, and, always with slow and steady movements, insert the hinged portion of the suspension arm well home into the socket. See that the screws which secure the instrument in its gimbals are screwed home, otherwise it may slip through its supports.

The height of the barometer should be such that the setting can be made and the scale read comfortably by the observer when standing upright.

The method of suspension by gimbals ensures that when the instrument is hanging freely the scale is vertical. This is an important point, because even a slight deviation from the vertical will cause the barometer to read too high. Some barometers are provided with a ring, which screws into the wall at the level of the cistern, so that the latter hangs within it. In the ring are three equally-spaced set screws which project radially into the ring. The set screws are turned in until each almost touches

the cistern. The barometer is thus kept in a vertical position. Once in position, the set screws should not be touched except for an occasional readjustment which may be necessitated by warping of the mounting or creeping of the screws.

The reading of the barometer is facilitated by pasting a sheet of white paper behind it, or, if it be in front of a window, by frosting the glass.

Reading the Barometer.

Barometers Graduated in Inches.

1. Observe the reading of the attached thermometer to the nearest tenth of a degree, and enter in the appropriate place in the Field Book. This is done first because the heat from the observer's body is likely to affect the thermometer more quickly than the mercury in the tube.

2. Many observers next lightly tap the tube of the barometer to prevent any sticking of the mercury to the sides of the tube. Some authorities, however, disapprove of this proceeding, and if tapping is done, it should be with the soft part of the fingers, and lightly only.

3. By turning the milled pinion head at the side of the instrument, raise the small scale, called the vernier, well above the top of the mercury, then screw down until the lower edge of the vernier and also the lower edge of the sliding piece at the back of the tube, which moves with it, appear in the same straight line, and just touching the uppermost part of the *meniscus* or domed surface of the mercury. A little light will then be visible under the vernier at each side of the apparent point of contact.

The instrument must be touched as lightly as possible, and on no account should the setting be made when it is depressed from the vertical position.

The object of the sliding piece at the back of the instrument is to assure that the observer's eye is at the same level as the top of the mercury column; if this is not the case, serious errors will be made, as will be seen from the accompanying diagram (Fig. 5). Errors of this nature, which are liable to be made whenever the index and the scale on which it is read are not in the same plane, are known as *errors of parallax.*

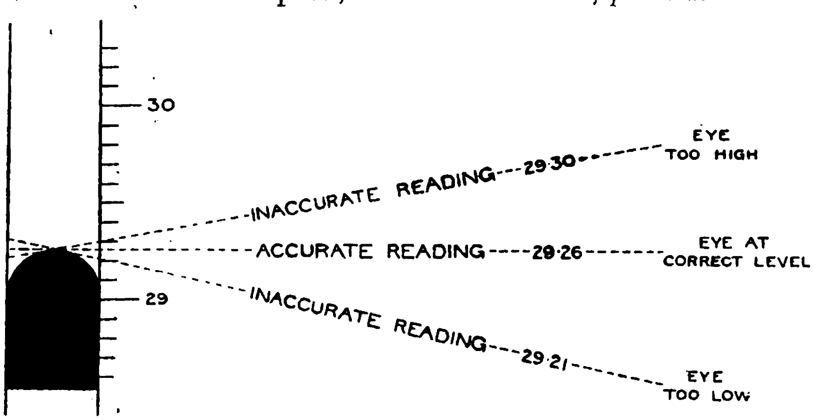


Fig. 5.

4. Note the reading on the fixed barometer scale of the line next beneath the lower edge or zero line on the vernier, that is, below the top of the mercury. The longer lines show tenths of an inch, and the shorter lines divide the tenths into two equal parts, each of which will, therefore, represent .05 inch. The lines on the barometer scale will then represent consecutively 29.500, 29.550. 29.600, 29.650 inches, and so on. In Figure 6, the reading of the division required, then, is 29.650.

5. Run the eye up the vernier scale until a line is reached, which is exactly level with some line on the fixed barometer scale. The position of this line is then read on the vernier scale and added to the reading of the fixed scale obtained above. Each of the larger lines in the vernier shows hundredths of an inch, and is numbered accordingly. There are four shorter lines between consecutive long ones, so that each of the smaller divisions represents one-fifth of one-hundredth of an inch, or .002 inch. Thus in the figure the reading is 2 hundredths and 6 thousandths, or .026 inch. The reading of the barometer is, therefore, as follows :—

From the barometer scale	..	29.650 inches.
From the vernier scale	..	.026 ,,
Resulting reading	..	29.676 ,,

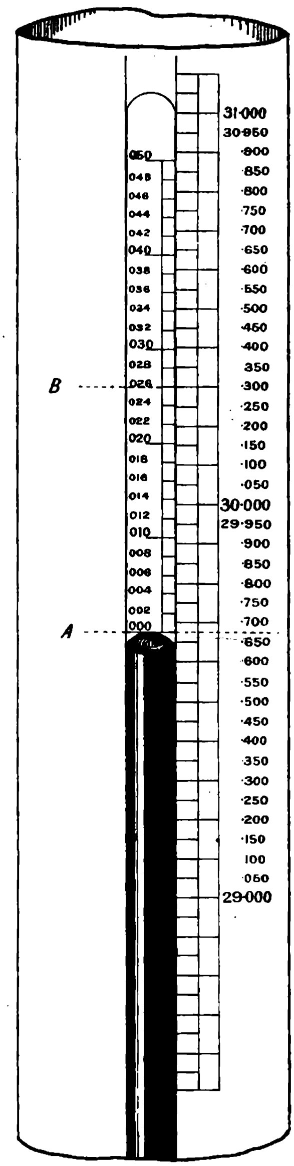


Fig. 6.

Sometimes no single line on the vernier will appear to be level with a division on the fixed scale, but two consecutive lines will appear equally nearly so. The correct reading is then the odd thousandth between the two divisions which appear to be nearly in contact with the divisions of the fixed scale. For instance, if in the figure the 26th and 28th divisions in the vernier each appeared nearly on a level with divisions in the fixed scale, the one being slightly below and the other slightly above, the correct vernier reading would be 27 and the barometer reading 29.677 inches.

The theory of the vernier is as follows :—25 of the small divisions on the vernier are equal in length to 24 on the fixed scale. That is, each of the vernier divisions is one twenty-fifth smaller than the fixed scale

divisions. Therefore, as one of the latter equals .050 inch, the vernier divisions are .002 inch smaller. In the figure, then, the 26th division on the vernier is level with a division on the fixed scale; the 24th division will be .002 inch higher than the next lower division; the 22nd .004 inch higher, and so on, the zero division being .026 inch higher than the 29.650 line of the fixed scale. So for any other reading of the vernier.

Before making a setting of the barometer it is well to check the previous reading if the vernier has not been moved in the meantime.

The Reduction of Barometer Readings.

A number of corrections must be applied to the reading obtained as described above.

(1) **Index Error.**—All barometers are tested at the National Physical Laboratory, or some similar institution, before sale. There is usually a slight residual error in the scale, even after corrections have been applied for gravity, temperature, and height above sea level. This error is called the index error, and is supplied in the certificate issued with the barometer. The barometer reading should be corrected by adding or subtracting the index error. There is considerable danger of the index error being changed as the result of transportation of the barometer, especially if it has received rough treatment. The change may be due to straining of the parts, the escape of a small quantity of mercury from the cistern, or the entry of small air bubbles into the tube. Changing the tube will change the index error. It is, therefore, desirable to compare a barometer with a standard instrument whenever possible, in order to check its index error.

(2) **Temperature.**—Changes of temperature affect both the density of mercury and the length of the scale of the barometer. Therefore, under the same air pressure, two barometers at different temperatures would read differently. In order to make readings with different instruments and at different times and places comparable with one another, the readings are reduced to what they would have been under certain standard conditions of temperature. The temperature correction is complicated, owing to the fact that the scale is graduated to be correct at 15° Centigrade, while for the mercury the standard temperature is the freezing point of water, 32°. F. It is, therefore, impossible for the barometer ever to be under standard temperature conditions. The attached thermometer is for the purpose of making the temperature corrections. The amount of the corrections for each degree of temperature of the attached thermometer is given in Table VII(*b*) for Kew pattern, and in Table VII(*a*) for Fortin barometers. At temperatures below 29° the correction is positive, and above it negative.

(3) **Gravity.**—The force of gravity varies slightly with latitude, and hence there is need to reduce barometric readings to a standard latitude; 45° is the latitude adopted. The amount of correction for each degree of latitude is given in Table VIII. The correction is proportional to the pressure, and the table gives the values for pressures of 27 inches and 30

inches respectively. It is to be added or subtracted according as the sign in the table is + or —. The correction should be applied in all cases to the readings of barometers before publication, as well as those for index error and temperature.

REDUCTION TO MEAN SEA LEVEL.

For many purposes, of which the chief is the preparation of synoptic charts for the daily weather report and forecast, it is necessary to reduce barometer readings to a standard altitude, mean sea level being the one universally adopted. To effect the reduction an amount must be added to the observed reading, which is equal to the length of the column of mercury required to balance a column of air equal in height to the height of the cistern of the barometer above mean sea level. Now, the weight of such a column of air would depend on its density, which would in turn depend on the pressure, temperature, and humidity of the column. As the column is an imaginary one, the temperature and humidity assigned to it must necessarily be arbitrary. The desire is to adopt such values as would make the resulting corrected barometer readings comparable with surrounding ones at sea level, so as to enable correct deductions to be made regarding wind force and direction, future pressure changes, and the accompanying weather. So long as the altitude is not great this can be done, but at higher levels the temperature begins to become important and the effect of humidity appreciable. The result is that, for the same station readings, different sea level corrections would be appropriate at different times of day and in different weathers. High-level stations, therefore, almost invariably cause irregularities in the synoptic charts. In calculating the equivalent pressure of the imaginary column of air it is assumed that the top of the column is at the temperature of the air in the screen at the station. The temperature of the air would normally increase between station level and sea level, and an estimate has to be made of the proper rate of increase to adopt in order to get the correct mean temperature for the column. It is usual to assume a rate of decrease of temperature with altitude, or temperature "lapse rate," as it is called, derived from the mean of all observations made in the free air by means of instruments attached to kites, balloons, &c. Actually the lapse rate may vary from a negative value to a maximum positive value of about 18° F. per kilometre, according to the type of weather; hence the weakness of the altitude correction for high-level stations. Most often, the effect of humidity is neglected, but where allowed for a similar process to that for the temperature is adopted. Reductions to mean sea level for various heights, temperatures, and pressures are given in Table IX. In entering these tables, the air temperature to be used is that shown by the thermometer in the screen and not the attached thermometer. It is the temperature of the free air that is required.

The theory of the various barometer corrections is dealt with more fully elsewhere (pp. 126–129), where also the methods of computing the corrections are given.

The corrections for various conditions at each station are computed at the Central Weather Bureau, and are furnished to the observer in as compact a form as possible on a special card.

Defects of Barometers.

The chief defect to which mercury barometers are subject is due to the accumulation of air in the space above the mercury. The presence of air may be detected by slightly inclining the tube so as to allow the mercury to flow slowly to the top of it. If a sharp metallic click is heard as the mercury strikes the glass, it may be assumed that no air is present. In some cases the air may be expelled by carefully inverting the barometer, but with the Kew pattern barometer this is often difficult, as the tube is very much constricted. It may be necessary to send the instrument to an instrument maker for repair, or to insert a new tube. In either case, the index error should be redetermined.

FIG. 7.

To prevent air and moisture working their way into the "vacuum" of a Kew pattern barometer, a small funnel or pipette is inserted between the cistern and the top of the mercury column (see Fig. 7). With this arrangement the air gets entrapped at the shoulder A, and does not affect the reading of the barometer.

The Fortin Barometer.

The Fortin pattern barometer is now used at so few stations that no description will be given of it here. When necessary, the *Observer's Handbook*, of the Meteorological Office, London, or any of the many other official books of instructions, may be referred to for information as to its care and use.

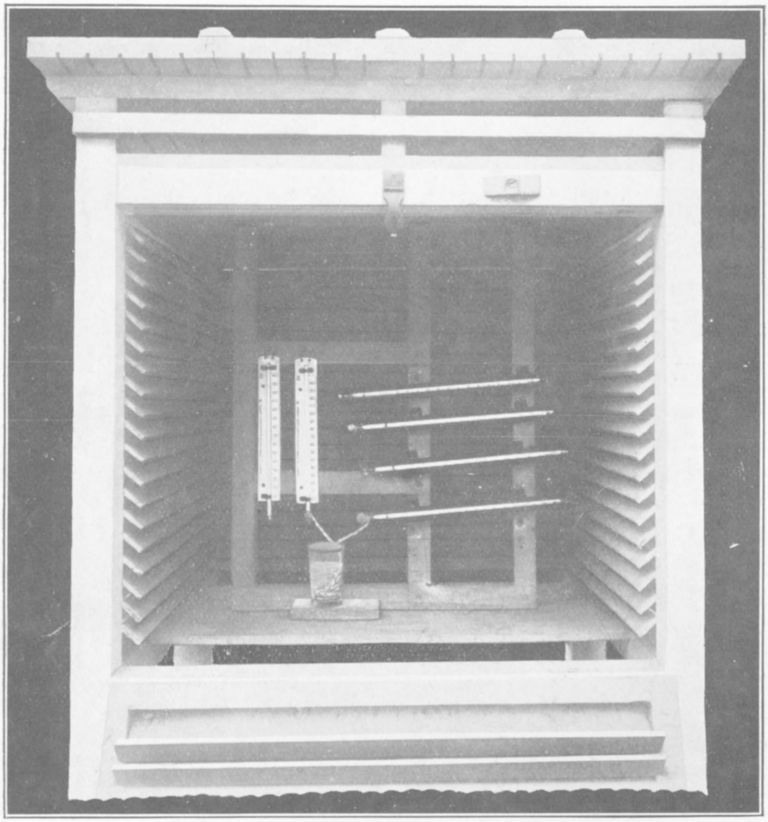


PLATE A.—FIG. 8.

ARRANGEMENT OF THERMOMETERS IN THE SCREEN.

To face page 31.]

The Thermometers.

The Screen.

The dry bulb, the wet bulb, and the maximum and minimum thermometers, and where used, the thermograph and hygrograph require to be placed in a screen of approved pattern. The screens in use in Australia at the present time, and all the new ones being manufactured, are of the Stevenson pattern.

The screen consists of a box or cupboard with double louvred sides. Specifications for its construction will be found elsewhere. (Plate E and p. 112.)

Exposure.--The conditions required for the exposure of the screen have been described on p. 13. It should stand on four legs so that its base is about 3 ft. 6 in. above the level of the ground. The legs must be sufficiently rigid and be buried sufficiently deeply in the ground to prevent shaking during gales. To prevent rot, the portions below ground should be treated with creosote or other preservative material. There should be no boarding or slab under the base of the screen.

The material taken from the hole in which the legs are fixed should be restored in as nearly as possible the order in which it was removed, so that the turf may be disturbed as little as possible. It will be an advantage to anchor the feet with large boulders, and the soil should be well rammed home round them.

It is not possible to give instructions which will meet every case. Thus, in some black soil areas, owing to cracking in dry weather, special precautions will be necessary to secure rigidity. Again, at some coastal stations, iron legs may be unsatisfactory owing to rusting. In such cases local experience and practice should be availed of.

At tropical stations, owing to the intense radiation from the sun and to the reflection of its heat from walls and the ground, it is sometimes desirable to protect the thermometers by means of a thatched shelter. Specifications for a suitable design are given on page 115.

Arrangement of the Thermometers in the Screen.

The points to be borne in mind in arranging the thermometers in the screen have already been detailed on page 14. The same conditions apply to the recording elements of thermographs and hygrographs, to the ventilation of which special attention should be paid. The arrangement adopted at the Meteorological Bureau is illustrated in Figure 8, Plate A.

The Maximum Thermometer.

The maximum thermometer is designed to record the highest temperature experienced during a given period. The form used in the Australian service (see Fig. 9) is a mercury thermometer, and has a constriction in the bore at about 1 inch from the bulb. The constriction is made

either by drawing the tube when softened by heat or by inserting a piece of glass. The thermometer is hung nearly horizontal with the bulb end slightly lower than the other. As the temperature rises the mercury expands and is forced past the constriction, but when a subsequent fall of temperature causes a contraction of the mercury the thread breaks at the constriction, so that its upper end remains in position to register the highest temperature reached.

The stem of the maximum thermometer should be graduated from 0° F. to 150° F.

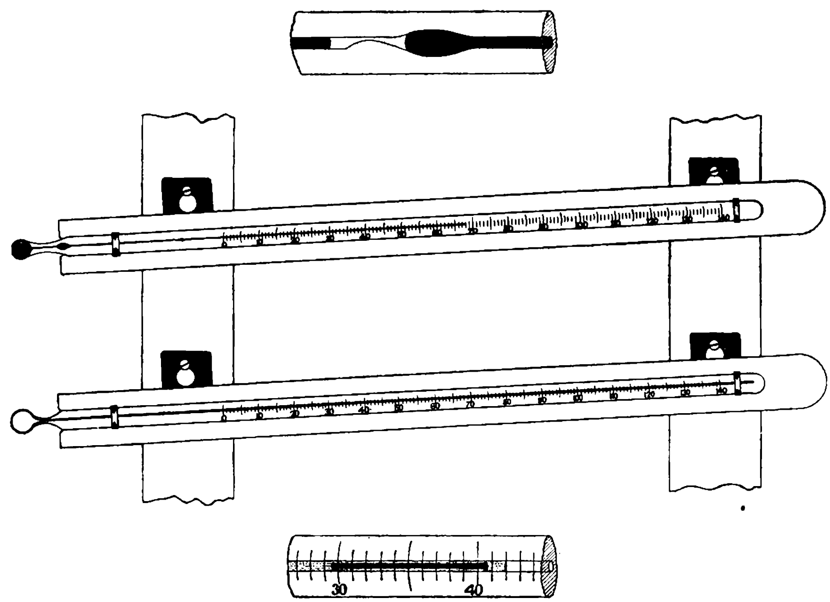


Fig. 9.

The Minimum Thermometer.

The minimum thermometer records the lowest reading experienced in a given interval. The most common type of instrument is a spirit thermometer having a small index in its stem. It is hung like the maximum thermometer (see also Fig. 9). As the temperature falls the index is carried towards the bulb by the spirit, but if the latter subsequently expands in consequence of a rise of temperature, it flows past the index, which is left in position to indicate the lowest temperature reached.

Portions of the maximum and minimum thermometers showing the constriction in the tube and the index respectively are shown enlarged in the small diagrams of Fig. 9.

The stem of the minimum thermometer should be graduated from −20° F. to 130° F.

General Hints on the Management of Thermometers.

The thermometers should be kept clean and the bulbs bright. If water has condensed on any of the thermometers, it should be wiped off and several minutes should be allowed to elapse before the readings are taken.

Blacking the Scale.—Should the divisions of the scale become indistinct, they may be improved by rubbing with a soft black lead pencil or with a mixture of black lead or lampblack and oil, which catches in the divisions but can be rubbed off the intervening spaces by passing the finger or a cloth lightly over the scale.

Bubbles in Stem of Spirit Thermometers.—Spirit thermometers should be regularly examined for the presence of bubbles in the stem or bulb, or of drops of liquid in the upper part of the stem or in the small bulb at its end. To remedy this defect when present, hold the thermometer with the bulb downward and the tube vertical, and jolt the bulb end of the frame, or, if there be no frame, the hand holding the thermometer, gently against a soft pad. One's knee or hand, or a thickly-folded table cloth forms a very suitable pad to prevent the jar being too severe. By repeating this treatment several times, detached globules of spirit may be made gradually to approach the main bulk of the spirit, and ultimately the whole thread becomes continuous. Another method which may be tried if the above is unsuccessful is to swing the thermometer sharply downwards from above the head with a circular motion, the elbow being kept bent and rigid, and the thermometer bulb directed outwards.

After the column has been completely united in one of the above ways, the thermometer should be left vertical for some hours with the bulb downwards, to allow any liquid which may have been left on the walls of the tube to drain down to the main column.

In hot climates, spirit thermometers are a frequent source of trouble, and should be especially watched in order to prevent the development of any of the defects above mentioned. It may be advisable occasionally to let the thermometer stand vertical for some hours in the manner described.

Should the thermometer prove refractory, every effort should be made to keep a check on its errors, and the nearest Meteorological Bureau should be notified of the trouble, so that the thermometer may be replaced.

Occasionally the thread of a mercury thermometer gets broken. The defect may be remedied by jolting in the manner described above.

Defects of Maximum Thermometers.—Maximum thermometers are subject to two defects :—

(1) The mercury may recede to a greater or less extent from the maximum reading when the temperature falls. A defect of this kind will usually be soon detected, but where the thermometers are read

once a day only the observer should test the maximum by heating it gently (e.g., with the fingers) and noting whether the mercury column retains its maximum position in the tube.

(2) The mercury may slip forward when the instrument is replaced in position after setting, and thus give too high a reading.

Both of these defects may in most cases be remedied by altering the inclination at which the instrument hangs.

Reading the Thermometers.

Sighting.—As the mercury thread and the scale of the thermometer are not in the same plane, errors of *parallax* (see p. 26) will be made unless the observer is careful that the line joining his eye to the point of the scale at which the reading is to be made is at right angles to the stem of the instrument. The best indication that this is the case is generally given by the scale divisions themselves. The divisions are circular arcs on the stem of the thermometer, and will only appear as straight lines at the point of the stem directly opposite the observer's eye.

Degree of Accuracy Required.—Accuracy is especially important in the reading of the wet and dry bulb thermometers, as it is on the *difference* between these readings that the values deduced for the vapour pressure and humidity depend. It is well to make a practice of reading thermometers to tenths of a degree. The mental processes by which this is done are different for different observers. The best way to attain skill is by repeated estimation to the nearest tenth of fractions of some interval for which the accuracy can subsequently be tested.

Rapidity.—The thermometers should be read as rapidly as is consistent with accuracy, in order to avoid changes of temperature due to the presence of the observer. When observing with artificial light, care must be taken not to heat the thermometers with the lamp.

Hours of Observation and Setting.—It was agreed at the Congress at Vienna that the operation of setting the maximum and minimum thermometers should be performed only once in 24 hours, and that the latest hour of observation should be selected for the purpose. In making the last proviso, however, it was assumed that observations would be made at 6 p.m. or some later hour than 3 p.m., which is not a suitable time for setting the maximum. In Australia, therefore, the following rules should be observed :—

(1) At stations at which no 9 p.m. observations are made, the maximum and minimum thermometers should be read and set at 9 a.m.

(2) Where 9 p.m. observations are made, the maximum and minimum should be read and set then (but unless this is done regularly it is preferable to adhere to the morning setting). They should be read also at 9 a.m. At stations whence 3 p.m. telegraphic reports are sent, the maximum thermometer has to be read at that hour also.

Where 9 p.m. observations are made, the maximum and minimum then recorded should be adopted as the readings for the day on which they are made. Elsewhere the reading of the minimum at 9 a.m. should be adopted for the day on which it is made and of the maximum for the preceding day.

Reading and Setting.—The following procedure should be adopted when making a reading :—

(1) Enter the readings of the dry bulb and wet bulb and the maximum and minimum thermometers in the appropriate columns of the Field Book. In the case of the first three instruments, the position of the end of the mercury column is observed; in the case of the minimum thermometer the position of the end of the index furthest from the bulb.

(2) Check these entries—

(*a*) By comparing them again with the instrumental readings, special attention being directed towards making sure that no errors of 5° or 10° have been made.

(*b*) By ascertaining that the readings of the maximum and minimum thermometers are respectively as high or higher, or as low or lower, than the dry bulb readings taken at or since the previous setting ; the maximum reading should be at least as high and the minimum at least as low as those readings.

(3) The maximum thermometer may be set by swinging it briskly through the air, the bulb being held away from the observer. The thermometer should be kept in the shade during this process. The bulb of the minimum thermometer should be tilted upwards until the end of the index slides into contact with the spirit surface. Should the index stick, light tapping will generally release it.

(4) Test the setting by seeing that the maximum and minimum both read the same as the dry bulb. The readings should be entered in the Field Book.

Terrestrial Radiation Thermometer.

The object of the terrestrial radiation thermometer is to secure some estimate of the effectiveness of the radiation from the earth's surface at night time. A minimum thermometer exposed freely over a grass surface is used. It should not be protected by wire netting or other kind of frame. In order that the results from different stations should be comparable, the thermometer should be of a standard size and pattern. The stem is usually enclosed in an outer glass jacket, which serves the double purpose of protecting the graduations and rendering the distillation of spirit to the upper portion of the tube improbable. The stem of the grass minimum thermometer should be graduated from – 30° F. to 130° F. The thermometer should be supported on two Y-shaped pieces of wood at a height of 1 or 2 inches above the ground, which latter should be covered with short grass. Care should be taken that the bulb does

not touch the supports. The thermometer should be well removed from any large object above ground. It must be remembered that the instrument is intended to give, not the temperature of the air, but its own temperature as produced by radiation from the bulb to the sky. The sky should, therefore, be as little obscured as possible.

When the ground is covered with snow the thermometer should be supported above the snow surface, and as near to it as possible without touching it.

The grass minimum thermometer should be read and set at 9 a.m. Should the minimum for the preceding 24 hours occur at 9 a.m., however, this should be noted, so that, for instance, one day of frost should not be recorded as two.

In summer it is advisable to keep the grass minimum thermometer standing bulb downwards in the screen from 9 a.m. till evening, when it should be set and placed in the correct position on the grass. If the thermometer is exposed during the heat of the day there is considerable danger of bubbles forming in the stem or of the spirit distilling to the upper end of the tube.

Solar Radiation Thermometers.

The solar radiation thermometer was designed with a view to securing a measure of the maximum intensity of the solar radiation as it reaches the earth's surface during each day. Owing to the complexity of the conditions, it has not been found possible to give a precise interpretation to the readings of solar maximum thermometers, but the readings are still kept up at a number of stations. As long as the same instrument is used, and in the same conditions, it is possible that interesting results may be derived from a long series of observations. Only instruments of standard pattern should be used. The solar radiation thermometer consists of a maximum thermometer encased in a glass jacket, which has been evacuated so that as little heat as possible is lost by conduction. In order to make the mercury absorb as much as possible of the sun's heat, the bulb and about 1 inch of the stem are coated with lamp-black. The stem of the thermometer should be graduated from 10° F. to 200° F.

The instrument should be fixed on a wooden stand at the same height as the maximum thermometer, and should be freely exposed to the sky on all sides. The bulb should be as fully exposed as possible to the sun when at its highest. The custom in the British Meteorological Service is to fix the thermometer in an east to west line, but at some places the bulb is directed towards the sun at mid-day, i.e., to the north in the southern hemisphere.

Earth Thermometers.

At a few stations the temperature of the ground at various depths below the surface is measured by means of thermometers suspended in iron tubes. The thermometers have to be withdrawn for reading, and it is, therefore, necessary to provide some means of protecting the bulb

from rapid changes in temperature. This is done by encasing them in paraffin or enclosing them in a small cylinder containing water. The reading must, however, be done in the shade, and quickly. To facilitate the latter, thermometers with open scales should be used. The lack of sensitiveness due to the water or paraffin surrounding the bulb does not impair the efficiency of the thermometer for its purpose, as the ground temperature changes but slowly.

Water must not be allowed to collect in the tubes. To prevent this, the tubes are fitted with small metal covers, to which the chains holding the thermometers are fastened.

Sea Temperatures.

(*a*) *At Coast Stations.*—Sea temperature readings are taken at some coast stations, although it is difficult, as a rule, to interpret them. In order that the temperature should be representative of general conditions in the neighbourhood, the test should be made in water that is not less than 6 feet deep. The thermometer should be plunged 1 foot under water and held there for three minutes, then brought to the surface and read promptly. If a canvas bucket and line are available, dip a bucketful of water from a suitable place, put the thermometer in the water in the bucket, and read after three minutes. Special care must be taken to avoid parallax.

(*b*) *On Board Ship.*—Draw a bucket of water from alongside and read the temperature as before. The bulb of the thermometer should in all cases be immersed while the reading is being taken.

Hygrometers.

The humidity of the atmosphere is usually determined from readings of dry and wet bulb thermometers placed in a Stevenson screen and mounted in the manner illustrated in Figure 10. The combination of the two instruments is known as a "psychrometer."

A wet bulb thermometer is made by coating the bulb of an ordinary thermometer with muslin kept moist with water. Its action depends on the fact that evaporation takes place from every free water surface as long as the air in contact with it is not saturated with aqueous vapour. The heat required to bring about this evaporation is, in the case of the wet bulb, taken in part from the thermometer itself, and hence a wet bulb generally reads lower than a dry bulb placed in the same screen. In a saturated atmosphere both instruments should read the same. In unsaturated air the amount of lowering depends on the rate of evaporation, and this in turn on the temperature and dryness of the air.

The relative humidity, dew point, pressure of aqueous vapour, &c., corresponding to various readings of dry and wet bulb thermometers are obtained from tables (see Tables pp. 132–148).

In recent years additional importance has been attached to the readings of the wet bulb thermometer. This is not only on account of their use as a means of determining the percentage humidity, but also because of their intrinsic significance. The human body itself acts very much like a wet bulb thermometer, and is kept at its normal temperature by the cooling due to evaporation from the skin and lungs. The wet bulb thermometer, then, gives an indication of the degree of comfort of atmospheric conditions, and is, consequently, a very important climatic factor.

If the wet bulb reads higher than 80° F., the body has distinct difficulty in throwing off heat sufficiently rapidly, and conditions are very oppressive. At readings higher than about 84° F. it becomes no longer possible to maintain the balance, and the bodily temperatures begins to rise. Should such conditions be prolonged, death will ultimately ensue. Another important factor in human comfort is the absolute humidity, or the amount of water vapour present in each unit of volume of the air. As the body is kept by the blood at a constant temperature, it is obvious that just at the surface of the skin the conditions must depend largely on the absolute humidity.

Again, humidity, either absolute or relative, is important in a number of industrial connexions, such as cold storage, mining, ventilation, and the maintenance of electrical insulation.

From a scientific point of view the wet bulb reading is important, in that it is perhaps the best index of the condition of the atmosphere as regards its heat content, as it takes account of the heat stored in the form of latent heat of water vapour.

Observers, therefore, are specially requested to read carefully the following instructions regarding the care of the wet bulb, and to take every precaution to secure accurate observations. Readings above 80° F. should be regarded with suspicion while correct readings of 90° F. or over are practically impossible. The muslin must be kept clean and the bulb bright. It must be seen that water is supplied at the right rate to the bulb, which should be just moist all over, without any tendency for drops to form. Distilled water or rain water must be used.

Mounting of the Wet Bulb.

The wet bulb thermometer should be covered with a single thickness of thin clean muslin or cambric, which is kept moist by attaching to it a few threads of darning cotton (No. 8) dipping into a small reservoir of water placed near it. The muslin and thread must be entirely free from grease, otherwise they will not keep moist. To remove grease, they may be washed in water containing ammonia. Care must be taken that the muslin is stretched smoothly on the bulb, creases being avoided as far as possible. The muslin may be tied on to the bulb with a cotton thread, or it may be secured in position by looping three strands of the cotton used for supplying moisture to the bulb in a clove hitch, or in the manner shown in the figure. In the case of thermometers

with cylindrical bulbs, a small "finger" of muslin should be sewn to fit the bulb exactly. After fixing the muslin, it should be carefully trimmed with a pair of scissors; all superflous material and all loose ends should be cut off.

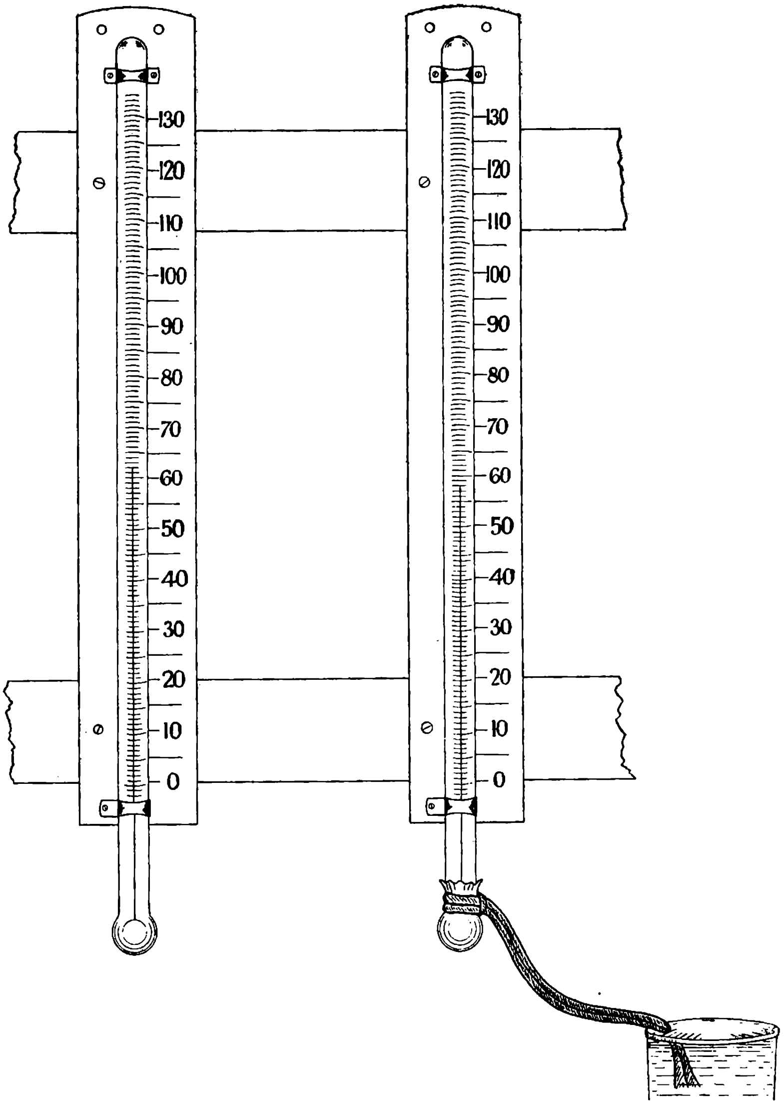


Fig. 10.

The muslin must be clean, and must, therefore, be changed before it gets dirty. In country districts it will generally suffice to change it once a week, but in towns this should be done oftener. The change should be made immediately after, or some time before observing. At least fifteen minutes should elapse between mounting and reading; if the

clean water supplied is not at the temperature of the air, a much longer time is required. Always make a note in the Field Book when the muslin is changed.

The water used for moistening the wet bulb must be soft. *Distilled water or rain water should be stored and used for the purpose.* If through some accident other water has to be used, it should be changed frequently. If hard water is used, the bulb and muslin soon becomes encrusted with a deposit, and the readings become inaccurate. Sea water must never be used.

At exposed seaside stations sea spray may reach the thermometer occasionally in rough weather. In such cases, the muslin should be replaced at the first opportunity. After dust storms also the bulb may become dirty, and a change of muslin be required.

The vessel containing the water supply should be placed below, and a little to one side of the bulb of the thermometer, as shown in Figure 10. In order to avoid breakage of the water vessel during frost, it should not be filled beyond the line of its widest part.

The part of the cotton thread exposed to the air should be between 3 and 6 inches in length ; it must be kept as straight as possible. If it be allowed to hang in a loop, water will drip down from the lowest point of the curve until the reservoir is emptied.

The value of the readings depends greatly on supplying moisture to the wet bulb at the proper rate. In warm dry weather there is danger of the water evaporating too rapidly from the conducting threads, so that the muslin is left dry, and, on the other hand, in damp cold weather drops of water may collect on, or even drip down from, the bulb of the thermometer. Both defects render the reading too high. They may be avoided by adjusting the distance between the thermometer and the water reservoir.

Unless the vessel containing the water has a small neck it should have a cover (through which the cotton passes by a small hole), so that the air inside the screen may not be moistened by the evaporation from the vessel.

If the reading of the wet bulb is above that of the dry, make sure first that there is no error in reading, and that there is still an excess when the known corrections have been applied. Then see if moisture has been deposited on the bulb of the dry. If this is the case, wipe the bulb dry and read again after waiting a minute or two for the thermometer to take up the temperature of the air.

If there is no evidence of moisture, make two or three more observations of both instruments at intervals of about two minutes. It will usually be found in that case that the temperature is falling, and that the wet bulb eventually falls below the dry, although at first the dry may fall more rapidly than the wet.

In the first of these two cases the peculiarity is due to the fact that the dry bulb is acting as a wet bulb, and is giving a temperature below the true air temperature. This will usually happen when the temperature

is rising. In the second case, the wet bulb is lagging more than the dry in air in which the temperature is falling, and the wet-bulb reading is too high.

The amount by which the temperature of the wet bulb is reduced below that of the dry is found to depend on the ventilation to which the instruments are exposed. On calm days the observer will frequently be able to reduce the temperature of the wet bulb by a degree or more by fanning it. The necessity of devising a trustworthy instrument for the measurement of temperature and humidity directed attention to this point, and led to the invention by Professor Assmann of the ventilated psychrometer. Table VI. at the end of this book should not be used for observations with the ventilated or the sling psychrometer (see p. 124).

Management of Wet Bulb during Frost.

The management of the wet bulb during frost, or at times when the wet-bulb reading is below 32°, is troublesome, as the freezing of the water on the conducting threads cuts off the supply of moisture to the muslin. In order to secure satisfactory results, the bulb must be coated with a thin layer of ice, from which evaporation takes place as from water. It is, therefore, necessary to wet the muslin slightly with ice-cold water by means of a camel-hair brush or feather ten or fifteen minutes before observing. After the moistening of the muslin, the temperature remains steady at the freezing point, 32°, until all the water has been converted into ice, and it then commences to fall gradually to the true wet-bulb reading. No reading should be recorded until the temperature of the wet bulb has fallen below that of the dry bulb and become steady.

The water used must be at the freezing-point (it is best taken from under ice), otherwise a very much longer period is required for it to cool. As little water as is consistent with thorough moistening of the muslin should be used. If excess is put on, not only is the time of waiting much increased, but a thick layer of ice forms on the thermometer, which interferes with the accuracy of this and subsequent readings. When this occurs, the ice must be removed by immersing the bulb in warmed water.

After water has been applied, the temperature of the wet bulb may fall considerably below the freezing-point without the formation of ice, the water being supercooled. At the moment of solidification the temperature rises to 32° F. and then commences to fall again. The temperature finally reached should be entered as the correct wet-bulb reading. During prolonged frost it is not necessary to renew the ice-coating before every observation.

The Rain Gauge.

The funnel of the gauge should be circular, with a knife-edge rim, and 8 inches in diameter. Tests should be made occasionally to see that this is so, and that the rim is level. The gauge should also be examined regularly to see that no leaks have developed, especially round the rim.

Absence of Observer.—An assistant should, if possible, be trained to measure the rainfall in the absence of the observer. When no such

provision can be made, arrangements should be made to have the gauge visited at the usual hour, and the water bottled and labelled, to be kept until the observer returns.

Hour of Observation.—The rainfall should be measured at 9 a.m. daily, and the amount entered against the date on which it is measured. At those stations at which the rain is measured in the afternoon for report by telegraph, it should be returned to the gauge, so that at 9 a.m. the total fall for 24 hours is measured.

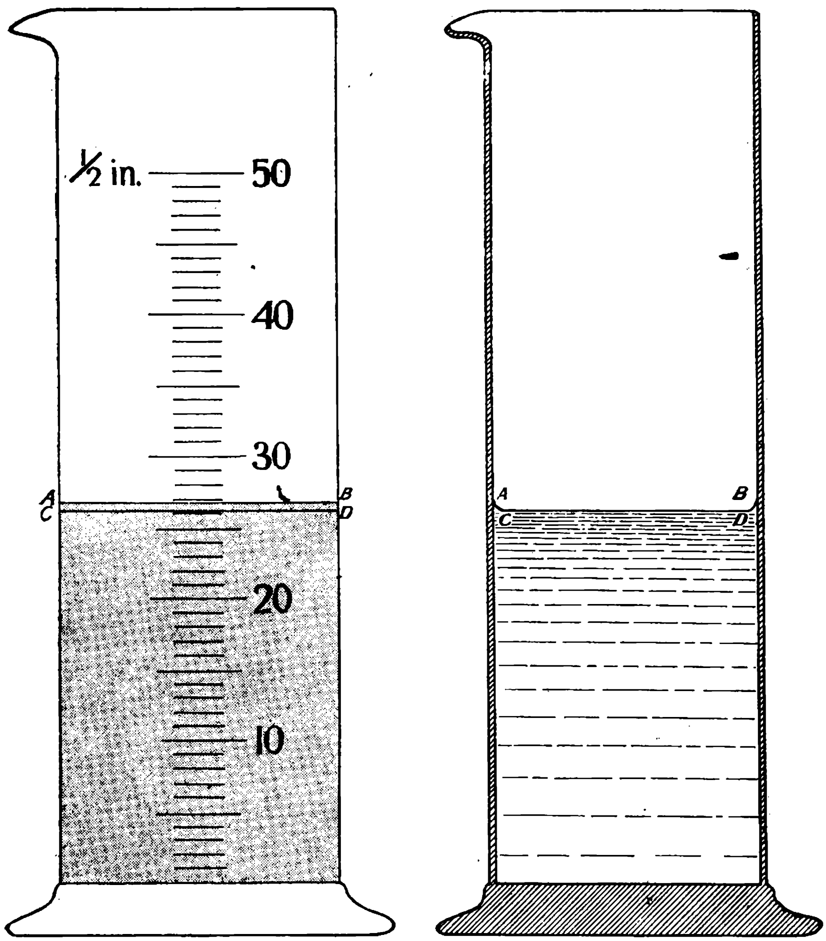


FIG. 11.

Measuring the Amount of Rainfall.—The rain in the gauge should be poured carefully into the glass measure. The glass should then be held near the top, so that it will hang vertical, or placed on a level surface during the making of the reading. The eye should next be brought to the level of the surface of the water, when the level portion of the latter will appear as a straight line. The lower portion of the curved surface, the bottom of the "meniscus," as it is called, should then be read off

on the scale, not where the surface curves up the sides of the vessel The measure-glass is illustrated in Figure 11, the right-hand figure being in section. The water climbs up the side of the glass, reaching the level AB, while the general surface is at CD, which is the level to be read. Each division on the measuring glass corresponds to one point, or one hundredth of an inch of rain. The reading given should be that of the *nearest* division to the water surface, not always the one just above or the one just below, but the one of these which is the nearer, e.g., in the figure, the reading is 26 points. After heavy falls, when there is more than enough rain to fill the measure beyond the 50 points mark, the reading should be made in two or more instalments. First fill the glass up to the 50 point mark, then empty into a jug or some such convenient vessel, then repeat the process until the residue is less than half an inch. The measurement should then be repeated, so as to make sure that there has been no mistake in counting the number of half-inches. The amount should be written down before the water is thrown away. If difficulty is experienced in filling the measure accurately to the 50th graduation, this may be done approximately, and each instalment read accurately. The readings are then added together, thus, $49 + 47 + 47 + 24 = 167$ points. In some countries, the rainfall is measured in millimetres, in which case the measure usually holds 10 millimetres. Readings are made to the nearest tenth of a millimetre. If the precipation measured is dew, a note should be made to this effect.

Heavy Rain.—Interest attaches to the rate at which rain falls, especially during heavy rains. Self-recording gauges are, of course, best adapted for giving this information, but useful data can frequently be obtained by noting the time of beginning and ending of a heavy shower and measuring the amount at its cessation. The rain should be returned to the gauge. Very rarely the fall in 24 hours is so heavy that the gauge will overflow. Should there appear to be any danger of this, the amount that has fallen should be measured and not returned to the gauge, care being taken to add the amount to the next morning's reading.

In cases where the precipitation has been in the form of snow or hail which has not melted, or if the water in the gauge has frozen, the funnel and receiver should be taken indoors and gently warmed until the ice or snow melts, when the measurement is made in the usual way. If, as may be the case at a few mountain stations, the fall has all been in the form of snow which has not melted appreciably, it may be roughly estimated by measuring the depth of the snow and taking a foot of snow as being equivalent to an inch of rain. In some cases, the snow may have been carried out of the gauge by eddies, and the above be the only method of measuring the amount of precipitation. The depth of the snow where it lies evenly on open ground should always be entered in the returns.

Rain-days.—A day is regarded as a rain-day if the fall has been over half a point, i.e., if a point of rain is recorded; were the fall less than half a point, the rain would be recorded as 0. In the latter case, however, the word "trace" would be entered in the return. If the precipitation has been in the form of dew, the day is not recorded as a rain-day.

Non-Instrumental Observations.

Wind.

A wind is completely specified when we know its direction and velocity. Its character, as regards steadiness or gustiness, should also be noted.

Wind Direction.

The convention adopted in recording wind direction is to state the *direction from which* it is blowing. The methods of specifying direction have been detailed above (p. 18). All directions should be "true" and not "magnetic", and estimated to the nearest of the following sixteen points of the compass :—

N	.. North	S	.. South
NNE	.. North-north-east	SSW	.. South-south-west
NE	.. North-east	SW	.. South-west
ENE	.. East-north-east	WSW	.. West-south-west
E	.. East	W	.. West
ESE	.. East-south-east	WNW	.. West-north-west
SE	.. South-east	NW	.. North-west
SSE	.. South-south-east	NNW	.. North-north-west

The direction required is that of the general current in the neighbourhood, and care must be taken to avoid being deceived by eddies due to buildings, trees, &c., or by the effects of the direction of streets. A well-exposed and sensitive wind vane is the best indication as to the direction of the wind. The drift of smoke from tall chimneys, or the set of flags, also give useful indications. The former, especially is convenient, as it eliminates the effect of rapid changes during gusts, a long trail giving the mean direction over a considerable interval. Observations of *distant* smoke or flags, &c., are, however, most unreliable, and should not be used. The effect of perspective makes it impossible to judge the direction of movement of distant smoke with any accuracy unless it is moving directly either towards or away from the observer.

If a wind vane be used, care must be taken—

(1) That it is freely exposed on all sides.

(2) That it moves freely. Before the wind vane direction is accepted, it should be noted that the vane is responding to the fluctuations in wind direction. If the wind is not sufficiently strong to move it, other means of ascertaining the direction must be used. A number of methods of estimating the direction of feeble winds have been devised. One is to moisten the fingers and rotate the body with them

extended ; when the fingers are facing the wind direction they will feel coldest. Another method is to run round in a circle, when the resistance of the air will feel greatest when running into wind.

(3) That the cardinal points, if indicated on the vane, are correctly set and that the vane is well balanced, i.e., that it has no bias to set itself in a particular direction.

Wind Force.

The force or velocity of the wind was, in the early days of meteorology, almost invariably estimated by its effect. Even now, the proportion of stations possessing anemometers is small, so that estimated values are still very generally used. The scale according to which the various speeds are designated was first developed by Admiral Beaufort, and his rules had reference to the effect of the winds on the sailing of a certain type of man-of-war, long obsolete. The scale, however, came into general use, and his rules were modified or supplemented to meet all circumstances.

The Meteorological Office, London, issued in 1906 a report on "An Inquiry into the Relation between Estimates of Wind Force according to Admiral Beaufort's Scale and the Velocities recorded by Anemometers." The Beaufort scale is a numerical one, ranging from 0 for a calm to 12 for a hurricane, and it was found that experienced observers were able to classify a wind with considerable accuracy, and that the range of velocities to which different observers would assign a certain force number was fairly constant. From a very large number of observations, therefore, a table was drawn up giving the mean equivalents of the Beaufort numbers in pressure on a disc 1 foot square or in actual velocities. The following table (p. 46) is based on this report. When estimating the force of the wind, the observer should either be himself in an exposed position or have in view objects such as trees, &c., on which the effects of the wind can easily be seen.

It must be remembered that the wind speed varies with height above ground. The table may be taken as referring to the wind at a height of 10 metres (33 feet) above an open level grassy surface. It is obvious that, for many reasons, the estimates cannot be very precise, but very considerable consistency is attained, and the results are of great practical value. In many cases the maximum velocities felt in gusts will give a good idea of the speed in the free air above the observer.

SPECIFICATION OF THE BEAUFORT SCALE WITH PROBABLE EQUIVALENTS OF THE NUMBERS OF THE SCALE.

Beaufort No.	Explanatory Titles.	Specification for Coast Use.	Specification of Beaufort Scale for Use on land, based on Observations made at Land Stations.	†Mean Pressure (at Standard density) on a disc of 1 sq. ft.		Equivalent speed in miles per hour at 33 ft.	Limits of Speed. At 10 m. (33 feet) in the open.		
				mb.‡	Lb. per sq. ft.		Miles per hour.	Metres per second.	Feet per second.
0	Calm	Calm	Calm; smoke rises vertically	0	0	0	Less than 1	Less than 0·3	Less than 2
1	Light air	Fishing smack* just has steerage way	Direction of wind shown by smoke drift, but not by wind vanes	·01	·01	2	1–3	0·3–1·5	2–5
2	Slight breeze	Wind fills the sails of smacks, which then travel at about 1–2 miles per hour	Wind felt on face; leaves rustle; ordinary vane moved by wind	·04	·08	5	4–7	1·6–3·3	6–11
3	Gentle breeze	Smacks begin to careen, and travel about 3–4 miles per hour	Leaves and small twigs in constant motion; wind extends light flag	·13	·28	10	8–12	3·4–5·4	12–18
4	Moderate breeze	Good working breeze; smacks carry all canvas, with good list	Raises dust and loose paper; small branches are moved	·32	·67	15	13–18	5·5–7·9	19–27
5	Fresh breeze	Smacks shorten sail	Small trees in leaf begin to sway; crested wavelets form on inland waters	·62	1·31	21	19–24	8·0–10·7	28–36
6	Strong breeze	Smacks have double reef in mainsail. Care required when fishing	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	1·1	2·3	27	25–31	10·8–13·8	37–46
7	High wind	Smacks remain in harbour, and those at sea lie to	Whole trees in motion; inconvenience felt when walking against wind	1·7	3·6	35	32–38	13·9–17·1	47–56
8	Gale	All smacks make for harbour, if near	Breaks twigs off trees; generally impedes progress	2·6	5·4	42	39–46	17·2–20·7	57–68
9	Strong gale	.. .. ..	Slight structural damage occurs (chimney pots and slates removed)	3·7	7·7	50	47–54	20·8–24·4	69–80
10	Whole gale	..	Seldom experienced inland; trees uprooted; considerable structural damage occurs	5·0	10·5	59	55–63	24·5–28·4	81–93
11	Storm	..	Very rarely experienced; accompanied by widespread damage	6·7	14·0	68	64–75	28·5–33·5	94–110
12	Hurricane	.. ..	.. ..	8·1	Above 17·0	Above 75	Above 75	33·6 or above	Above 110

* The fishing smack in this Table may be taken as representing a trawler of average type and trim. For larger or smaller boats and for special circumstances allowance must be made.

† The pressure due to the wind on any object exposed to it arises from the impact of the air on the windward side and suction on the leeward side; the mean pressure depends on the shape and size of the object. The values given are for a disc of 1 square foot in area, but they apply with fair approximation for circular or square plates from 1 sq. foot to 100 sq. feet in area.

‡ One millibar = 1,000 dynes per square centimetre = approximately 10 kilogrammes per sq. metre.

Clouds.

The object of cloud observations is to give information as to the state of the atmosphere and the processes going on therein, particularly as to the higher levels, and thus supplement the more precise observations which it is possible to make at the surface. The observations usually cover—

(1) The amount of cloud ;
(2) Its kind or kinds ;
(3) The direction and velocity of its movement.

Amount of Cloud.

The amount of cloud is indicated by stating the proportion of the sky covered by it according to a numerical scale. In some telegraphic codes the figures represent the number of quarters of the sky covered, but for all other purposes the amount is expressed in tenths, 10 representing completely overcast and 0 cloudless. The numbers should refer solely to the proportion of the sky covered, without regard to the density or other characteristics of the cloud. Thus the amount of cloud would be represented by 10 whether the sky was covered with thin and semi-transparent cirrus or by dense nimbus cloud. The fact that the appearance is very different in the two cases is taken account of by the designation of the nature of the cloud and the weather which is made at the same time.

To meet the requirements of aviators and some of the special methods of forecasting, it has been found necessary in Europe to give the proportion of the sky covered by the lowest type or types of cloud present, as well as the total amount of cloud.

Fog must be regarded as a cloud at ground level, and if the sky is obscured by it the amount must be given as 10. Sometimes there will be more or less obscuring by mist or haze ; but unless definite cloud is present, none should be recorded. The mist or haze should be referred to in the remarks or weather notes.

Direction and Velocity.

The direction of motion of clouds is always stated as the direction from which the cloud is coming. It is best observed by sighting the cloud against a fixed point. At night time, and when the cloud canopy is broken, stars near the zenith form very suitable fixed points. At other times the top of a flagstaff, gable of a house, &c., may be used. If the cloud motion is slow, the observer will find it advantageous to rest his head against some fixed support while taking the observation, otherwise the apparent cloud motion which he observes may be due to motion on his own part. To avoid errors due to perspective, he should stand, as near as may be, vertically below the fixed point, and confine his

attention to clouds near the zenith. A little experience will enable the observer to give a qualitative statement of the apparent velocity of clouds by means of such designations as slow, moderate, fast, &c.

For the accurate determination of the direction of motion of clouds, some form of nephoscope should be used. These instruments can also be used to determine the angular velocity of a cloud.

Cloud Forms and their Classification.

Clouds are of infinite variety in form, and consequently, if each form were to receive a separate name, the number of terms required would be infinite. There are, nevertheless, certain main classes of cloud which, in their typical forms, can be easily distinguished, and to avoid confusion these are used as the basis of all officially recognised classifications. A classification of this kind has been drawn up by a committee of the International Conference of Directors of Meteorological Institutes and Observatories, and approved by the Conference. This classification is given below, and until amended by another conference of equal authority should be adopted by every observer. It is not without its drawbacks, and will certainly fail to meet all the requirements of any one who makes a close study and keeps a detailed record of clouds. Such an observer can, however, supplement it by description and the use of recognized auxiliary terms so as to satisfy his needs. The original classification by Luke Howard, on which all modern ones are founded, was based solely on the form of the cloud. As the study of the upper air advanced, greater and greater importance came to be attached to the height of the cloud. The general use of pilot balloons, and the experience of aviators, in addition to organized determinations of cloud heights, have greatly added to our knowledge of clouds and our ability to estimate their heights. In any present day classification, therefore, the height should play at least as important a part as form. This is certainly the case in Australia, where the relation of appearance to height is in general simple, and where a knowledge of cloud movements, particularly of cirrus, is so great an aid to the forecaster. To the latter it is the information which cloud observations provide as to the structure and movement of depressions that gives them their greatest value. In a system of forecasting, which is being developed by French meteorologists, the relation of a cloud to the general cloud system is of prime importance.

Many of the difficulties in deciding what name to assign to particular clouds arise in connexion with stratiform types. These are of two main kinds—

(*a*) Continuous sheets, without structure, or with their under-surface thrown into waves or ripples ;

(*b*) Layers consisting of detached rolls, packs, or flakes of cloud.

Either type may occur at almost any altitude at which clouds are formed, and apart from change in density consequent on changes in height, there is practically no difference in form between the highest and the lowest. On the other hand, each shows a tendency to form at or about certain levels, and is less frequent at intermediate levels. Furthermore, the formation of such cloud at any one of the favoured levels is usually characteristic of certain types of weather. The division of the main types into such classes as would take account of these facts, therefore, seems desirable, and the height seems to afford the most rational basis of subdivision. For instance, type (*b*) includes (1) cirro-cumulus, which occurs most frequently in the middle stages of the advance of a depression ; (2) alto-cumulus, which generally precedes the rain, and covers large areas round the centre of the depression ; and (3) strato-cumulus, which is characteristic of anticyclonic weather. In type (*a*) are included cirro-stratus, alto-stratus, and stratus.

Some authorities consider that the term cirrus, including cirro-cumulus, should be applied only to clouds consisting of ice particles. Under this criterion, any cloud which produced a corona round sun or moon or showed iridescent colouring could not be classed as cirro-cumulus, as such phenomena are produced by diffraction by water droplets. The result would be that cirro-cumulus would seldom be recorded in Australia, while some very high clouds would have to be called alto-cumulus. There is the difficulty, also, that though cirro-stratus or cirro-cumulus in the form of ice particles may be present, there may be layers of thin cloud beneath, sometimes practically invisible, which consist of water particles, and may produce coronae. It does not seem desirable, therefore, to restrict the term cirrus to clouds consisting of ice particles.

The correct designation of cirrus clouds is perhaps the most important point in the identification of clouds. Cirrus is seen through a great depth of air, and consequently usually has a more or less hazy appearance. It is whiter than lower clouds, and without shadows. Alto-stratus, on the other hand, generally has a greyish, pearly, or smoky appearance. Halos are produced by refraction phenomena in ice particles, and are a reliable indication of cirrus.

Inexperienced observers are inclined to classify as cumulo-nimbus any cumuli-form cloud from which rain is falling. This should be guarded against. Cumulo-nimbus is a towering cloud, either a thunder cloud or approaching the latter in its scale of development.

Perhaps the best method of keeping a continuous record of the cloud is the graphical method described by Mr. E. T. Quayle while at the Melbourne Weather Bureau, but it requires more time than most observers are able to give to the subject. It must, nevertheless, be emphasized that accurate cloud observations are not possible without the devotion of considerable time to them. To understand the nature of a cloud it is frequently necessary to watch the processes of its development.

International Definitions and Descriptions of Cloud-Forms.

Of the following definitions, (1) to (10) are from the translation of the original French as it appears in the *Observers' Handbook* for 1921 (M.O. 191, London), with the heights added. The heights given are derived chiefly from the results of photographic measurements by the Melbourne Observatory, and apply, therefore, especially to Australian conditions.

(1) ***Cirrus (Ci.).**—Height,—20,000 feet to 50,000 feet; mean 32,000 feet. Detached clouds of delicate appearance, fibrous (threadlike) structure and feather-like form, generally white in colour. Cirrus clouds take the most varied shapes, such as isolated tufts of hair, i.e., thin filaments on a blue sky, branched filaments in feathery form, straight or curved filaments ending in tufts (called cirrus uncinus), and others. Occasionally cirrus clouds are arranged in bands, which traverse part of the sky as arcs of great circles, and, as an effect of perspective, appear to converge at a point on the horizon, and at the opposite point also if they are sufficiently extended. Cirro-stratus and cirro-cumulus also are sometimes similarly arranged in long bands.

(2) ***Cirro-Stratus (Ci-St.).**—Height,—20,000 feet to 40,000 feet; mean 30,000 feet. A thin sheet of whitish cloud, sometimes covering the sky completely, and merely giving it a milky appearance; it is then called cirro-nebula or cirrus haze; at other times presenting more or less distinctly a fibrous structure like a tangled web. This sheet often produces halos around the sun or moon.

(3) ***Cirro-Cumulus (Ci-Cu.).**—Height,—18,000 to 35,000 feet; mean 25,000 feet. (Mackerel Sky).—Small rounded masses or white flakes without shadows, or showing very slight shadow; arranged in groups and often in lines. French, *Moutons*; German, *Schäfchen-wolken.*

(4) **Alto-Cumulus (A-Cu.).**—Height,—10,000 feet to 23,000 feet, mean 17,000 feet. Larger rounded masses, white or greyish, partially shaded, arranged in groups or lines, and often so crowded together in the middle region that the cloudlets join. The separate masses are generally larger and more compact (resembling strato-cumulus) in the middle region of the group, but the denseness of the layer varies, and sometimes is so attenuated that the individual masses assume the appearance of sheets or thin flakes of considerable extent, with hardly any shading. At the margin of the group they form smaller cloudlets resembling those of cirro-cumulus. The cloudlets often group themselves in parallel lines, arranged in one or more directions.

(5) **Alto-Stratus (A-St.).**—Height,—higher type, 18,000 feet to 30,000 feet; lower type 7,000 feet to 18,000 feet. A dense sheet of a grey or bluish colour sometimes forming a compact mass of dull grey colour and fibrous structure. At other times the sheet is thin, like the denser

* It may be noted that the outline of the sun is visible, and his rays cast a shadow in spite of the presence of clouds of these types, unless the clouds and the sun are both low down on the horizon.

forms of cirro-stratus, and through it the sun and the moon may be seen dimly gleaming as through ground glass. This form exhibits all stages of transition between alto-stratus and cirro-stratus, but, according to the measurements, its normal altitude is about one-half of that of cirro-stratus.

(6) **Strato-Cumulus (St-Cu.)**.—Height,—2,000 feet to 10,000 feet. Large lumpy masses or rolls of dull grey cloud, frequently covering the whole sky, especially in winter. Generally strato-cumulus presents the appearance of a grey layer broken up into irregular masses, and having on the margin smaller masses grouped in flocks like alto-cumulus. Sometimes this cloud-form has the characteristic appearance of great rolls of cloud arranged in parallel lines close together. (**Roll-cumulus** in England, **Wulst-cumulus** in Germany). The rolls themselves are dense and dark, but in the intervening spaces the cloud is much lighter, and blue sky may sometimes be seen through them. Strato-cumulus may be distinguished from nimbus by its lumpy or rolling appearance, and by the fact that it does not generally tend to bring rain.

(7) **Nimbus (Nb.)**.—Height uncertain, probably almost the same as for cumulus. A dense layer of dark shapeless cloud with ragged edges, from which steady rain or snow usually falls. If there are openings in the cloud, an upper layer of cirro-stratus or alto-stratus may almost invariably be seen through them. If a layer of nimbus separate in strong wind into ragged cloud, or if small detached clouds are seen drifting underneath a large nimbus (the " scud " of sailors), either may be specified as **Fracto-Nimbus (Fr-Nb.)**.

(8) **Cumulus (Cu.)**.—Height,—about 1,500 feet to 15,000 feet. (Woolpack or Cauliflower Cloud).—Thick cloud, of which the upper surface is dome-shaped, and exhibits protuberances, while the base is generally horizontal. These clouds appear to be formed by ascensional movement of air, in the day time, which is almost always observable. When the cloud and the sun are on opposite sides of the observer, the surfaces facing the observer are more brilliant than the margins of the protuberances. When, on the contrary it is on the same side of the observer as the sun, it appears dark with bright edges. When the light falls sideways, as is usually the case, cumulus clouds show deep shadows.

True cumulus has well-defined upper and lower margins ; but one may sometimes see ragged clouds—like cumulus torn by strong wind—of which the detached portions are continually changing. To this form of cloud the name **Fracto-Cumulus** may be given.

(9) **Cumulo-Nimbus (Cu-Nb.)**.—Height may cover almost whole range of preceding clouds. The Thunder Cloud ; Shower Cloud.—Great masses of cloud rising in the form of mountains, or towers or anvils, generally having a veil or screen of fibrous texture (false cirrus) at the top, and at its base a cloud-mass similar to nimbus. From the base

local showers of rain or of snow, occasionally of hail or soft hail, usually fall. Sometimes the upper margins have the compact shape of cumulus, or form massive heaps round which floats delicate false cirrus. At other times the margins themselves are fringed with filaments similar to cirrus clouds. This last form is particularly common with spring showers. The front of a thunderstorm of wide extent is frequently in the form of a large low arch above a region of uniformly lighter sky.

(10) **Stratus (St.).**—Height,—from surface to 7,000 feet. A uniform layer of cloud, like fog, but not lying on the ground. The cloud layer of stratus is always very low. If it is divided into ragged masses in a wind or by mountain tops, it may be called **Fracto-Stratus.** The complete absence of detail of structure differentiates stratus from other aggregated forms of cloud.

The following remarks are added in the international atlas as instructions to observers :—

(*a*) In the day time in summer all the lower clouds assume as a rule special forms more or less resembling cumulus. In such cases the observer may enter in his notes "**Stratus** or **Nimbus-cumuliformis.**"

(*b*) Sometimes a cloud will show a mammillated under surface, and the appearance should be noted under the name **Mammato-cumulus.**

(*c*) The form taken by certain clouds, particularly on days of sirocco, mistral, föhn, &c., which show an ovoid form with clean outlines and sometimes irisation, will be indicated by the name lenticular; for example, **cumulus lenticularis, stratus lenticularis** (Cu-lent., St-lent.).

(*d*) Notice should always be taken when the clouds seem motionless or if they move with very great velocity.

A definition of the lenticular form of cloud is necessary. It may be put in the following words :—

(11) **Lenticular Cloud Banks.**—Banks of clouds of an almond or airship shape, with sharp general outlines, but showing on close examination fretted edges formed of an ordered structure of cloudlets similar to alto-cumulus or cirro-cumulus, which is also seen in the bank itself when the illumination is favorable. Sometimes the body of the cloud bank is dense, and the almond shape is complete, fore and aft, but sometimes the bank thins away from the forward edge to clear sky within, so that it presents the appearance of a horseshoe seen in perspective from below at a great distance. The bank appears nearly or quite stationary, while the cloudlets move rapidly into it at one side, and away from it at the other.

(12) **Alto-Cumulus-Castellatus ; Turreted Alto-Cumulus.**—Miniature cumulus rising in many heads from a layer of alto-cumulus. This is not a common type of cloud, but is often a sign of rain, and possibly thunder, in the near-distant future.

In view of the almost infinite diversity which cloud phenomena present, the observer must not expect to be able to assign without hesitation all clouds to one or other of the types described. If he is unable to classify the clouds seen, he should note the fact in the register.

If abbreviations be used for the names of the cloud types, those given above should be employed.

Several different cloud forms will frequently be present simultaneously. In such cases the direction of motion of each type should be observed in the manner to be described below and noted in the register. The directions of motion of different clouds observed at one and the same time may differ very materially.

It will usually be found that if rain is falling clouds of nimbus type are present. But it must be noted that the definition of nimbus is not "any cloud from which rain falls." The falling rain is auxiliary to the definition of nimbus. Nimbus may be present without rain actually falling, and rain may fall when nimbus is not present. Attention is also directed to the following details :—

Undulated Clouds.—It often happens that the clouds appear to be arranged in rows like newly-ploughed land, or like waves on the surface of water. This occurs most frequently with cirro-cumulus, alto-stratus, strato-cumulus (roll cumulus), &c. It is important to note the direction of the rows. When two distinct systems are visible with rows in two different directions, so that the clouds appear to be made up of separate "flocks," the directions of the two systems should be noted. As far as possible, these observations should be taken of rows near the zenith, so as to avoid errors caused by perspective.

The Point of Radiation of the Upper Clouds.—These clouds often take the form of narrow parallel lines, which, by reason of perspective, appear to issue from a given point on the horizon. The "point of radiation" is the name given to the point where these belts or their prolongations meet the horizon. This point on the horizon should be indicated in the same manner as the direction of the wind—N., N.N.E., &c.

Cloud forms are not illustrated in this book, but reproductions of photographs of a number of selected types will be provided separately.

Weather.

In addition to the phenomena hitherto dealt with, of which it is endeavoured to keep precise records, the observer should keep an account of all weather changes and manifestations. The majority of the phenomena of interest are concerned with the appearance of water in the atmosphere in its various forms, and on that account the term "hydrometeors" is used in some countries to describe the whole class.

In England a system of notation devised by Admiral Beaufort, consisting, as a rule, of the initial letter of the phenomenon to be indicated, has been in use for many years. A second system, consisting of a series of symbols independent of any language, was agreed upon at a Meteorological Congress at Vienna.

In the following table is given a list of the letters of the Beaufort notation, together with the corresponding international symbols.

Intensity may be indicated by attaching "exponents" 0 or 2 to the symbols, thus— $\ast^{\circ}$ means light snow, $\ast^{2}$ heavy snow. No exponents other than 0 or 2 should be used with the international symbols.

Beaufort Letter.	International Symbol.	Description.
b	..	Blue sky, less than four tenths clouded
bc	..	A combination of blue sky and detached clouds, 4 to 6 tenths clouded
c		Sky mainly cloudy, but with breaks between the clouds, 7 or 8 tenths clouded
o	..	Overcast, 9 to 10 tenths clouded
g		Gloomy, dull
u	..	Ugly, threatening appearance
e		Wet air, without rain falling
y	..	Dry air
r	●	Continuous or steady rain
d	●°	Drizzle
s	✱	Snow
s and r	✱	Snow and rain together

Beaufort Letter.	International Symbol.	Description.
p	●	Passing showers
h	▲	Hail
	△	Soft hail, sleet
	⟵	Ice crystals
	⊠	Snow on ground
	╪→	Snow drift
		Gale
q		Squally
l	<	Lightning
t	T	Thunder
	℞	Thunderstorm
f	≡	Fog
fe	≡:	Wet fog
m	≡°	Mist
	≡	Ground fog
z	∞	Dust haze
w	⌓	Dew
x	⊔	Hoarfrost
	V	Rime
	~	Glazed frost
v	0	Unusually good visibility
		Mirage
	⊕	Solar halo
	⦶	Solar corona
		Lunar halo
		Lunar corona
	⌒	Rainbow
		Aurora
		Zodiacal light

Appearance of Sky : b, bc, c, o.—These letters are intended to refer only to the amount of cloud visible, and not to its density, form, or other quality. The latter are covered by the supplementary letters, g, u, m, z, &c.

Precipitation.—The international symbol ● is used for all three letters r, d, p of the Beaufort notation. They give useful information, however, and it is desirable to note the time of beginning and ending of heavy showers especially.

The letters sp, hp, or rhp, indicate that the showers consisted of snow, hail, or mixed rain and hail. Sleet is generally denoted by rs.

Hail.—Hail should be recorded even though only a few stones were seen, and the day entered as a day of hail. In soft hail the pellets are small and soft, resembling little snow pellets, while in true hail the stones are hard, and sometimes large. The size of large stones should be noted. A convenient method of determining the size is by weighing them, either singly or a number together.

Snow on Ground.—The international symbol should only be used if at least half of the country surrounding the station is snow-covered at the time of the morning observation. The depth of the snow should be measured by plunging a rule into it where it is lying evenly over the surface, and entered in the notes.

Fog, Mist, Haze.—These three words indicate a deterioration in the transparency of the lower layers of the atmosphere owing to various causes, and sometimes the choice of the correct word is difficult. Fog should refer to surface cloud, i.e., in which the water particles are visible. Mist is caused by smaller and more transparent water particles, which render objects at a distance indistinct or invisible. Haze is the obscurity produced in a dry atmosphere by smoke, dust, &c., and the term should be used only when there is considerable difference between the readings of the wet and dry bulb thermometers. Fog will obscure near-by objects to varying degrees, and cause more or less inconvenience to traffic. The use of these words may be supplemented by a record of the visibility according to the recognized scale. If fog is restricted to certain areas this should be noted ; the duration of fog also is important.

Data referring to the visibility have become of greatly increased value owing to the development of aviation.

Wet Fog ; Ground Fog.—In a wet fog, moisture is deposited copiously on exposed surfaces. A ground fog is one which does not exceed the height of a man, at least in any density. It frequently occurs in winter over low-lying fields.

Dew.—Dew is moisture deposited on exposed surfaces owing to their being cooled by radiation during the night. The air in immediate contact with them is cooled until it can no longer retain all the moisture present. According to Aitken, the source of much of the moisture is the warm air expired by the soil.

Hoarfrost, Rime, Silver-thaw, Glazed Frost.—The value of these terms and the need to distinguish between them is not nearly so great in Australia as in the colder countries of the world. They all refer to

the deposition of ice in some form on exposed bodies. Some of the forms are practically never seen in Australia.

Hoarfrost resembles dew in its manner of formation. The cooling has been sufficient to solidify the water drops which, therefore, appear as white particles of ice on grass, roofs, &c.

Rime is an accumulation of frozen moisture on trees, &c., giving them a silvery white appearance. It is distinguished from glazed frost by its *rough* surface. *It is only formed during a fog*, and during its deposition the general mass of air is being cooled below freezing point. This distinguishes it from hoarfrost, which may be deposited when the air in general is well above freezing point. Hoarfrost is caused by *surface cooling by nocturnal radiation to a clear sky.*

Glazed frost is a transparent *smooth* coating of ice covering trees, buildings, &c. The phenomenon is usually caused by rain which freezes as it reaches the ground, and thus covers all objects with a coating of transparent ice. It may also be formed when a warm moist air current sets in suddenly after intense cold. The moisture of the air may then be condensed on cold surfaces, and cover them with a thin layer of ice. It is doubtful whether glazed frost is ever met with in our climate.

Thunder, Lightning, Thunderstorm.—A thunderstorm (ꓘ) should only be recorded on occasions when both thunder and lightning are observed. If either occur separately, an appropriate entry should be made. The times of occurrence, direction of motion, severity, &c., of a thunderstorm should be noted.

Globe Lightning ; Ball Lightning.—Globe lightning is now recognized as one of the phenomena of nature. It consists of a glowing ball of incandescent matter usually associated with a lightning flash. Sometimes the ball will explode with varying degrees of violence. Its movements are often quite leisurely and erratic. The precise nature and cause of ball lightning is not understood. The matter composing it appears to have been activated in some way by the electrical energy of the lightning discharge. It is possible that sub-atomic changes are involved. Accurate descriptions of apparitions of this phenomenon are extremely valuable, and may lead to the discovery of its nature.

Gale.—A gale is a wind of force 8 or over, and its occurrence should be recorded, together with the times of commencement and abatement and its greatest force.

Visibility.—The measurement of visibility will be dealt with elsewhere. The letter " v " is used to denote unusual transparency of the atmosphere, whether the sky be cloudy or not. In some places this is characteristic of certain types of weather.

Optical Phenomena in Atmosphere.

The optical phenomena which may be recorded by observers are extremely numerous and varied. Some are of very striking beauty. It is desirable to record them, not only on account of the interest excited by the phenomena themselves, but also because they may convey valuable information. For instance, a halo is produced only by refraction and reflection of light by ice particles, while coronae are produced by diffraction

by water drops. The appearance of either may, therefore, help to distinguish between different types of cloud. From the forecasting point of view optical phenomena have not been found of such value in Australia as in, say, Europe. Nor is their diversity as great in the higher latitudes. Halos of simple type, coronae and iridescence are, however, very common in Australia ; far more so, in fact, than is realized by most meteorologists.

Halo.—Halos may be produced by either sun or moon, the only difference being that, owing to the reduced amount of light from the moon, the range of types is reduced, and the colour effects are much less brilliant. The most common is the *halo* of 22°—a circle CIBG (Fig. 12) round the sun or moon, the radius of which is very nearly 22°, i.e., it subtends an angle of 22° at the eye of the observer, or covers an arc of 22° on a great circle passing through the sun or moon. The degree of

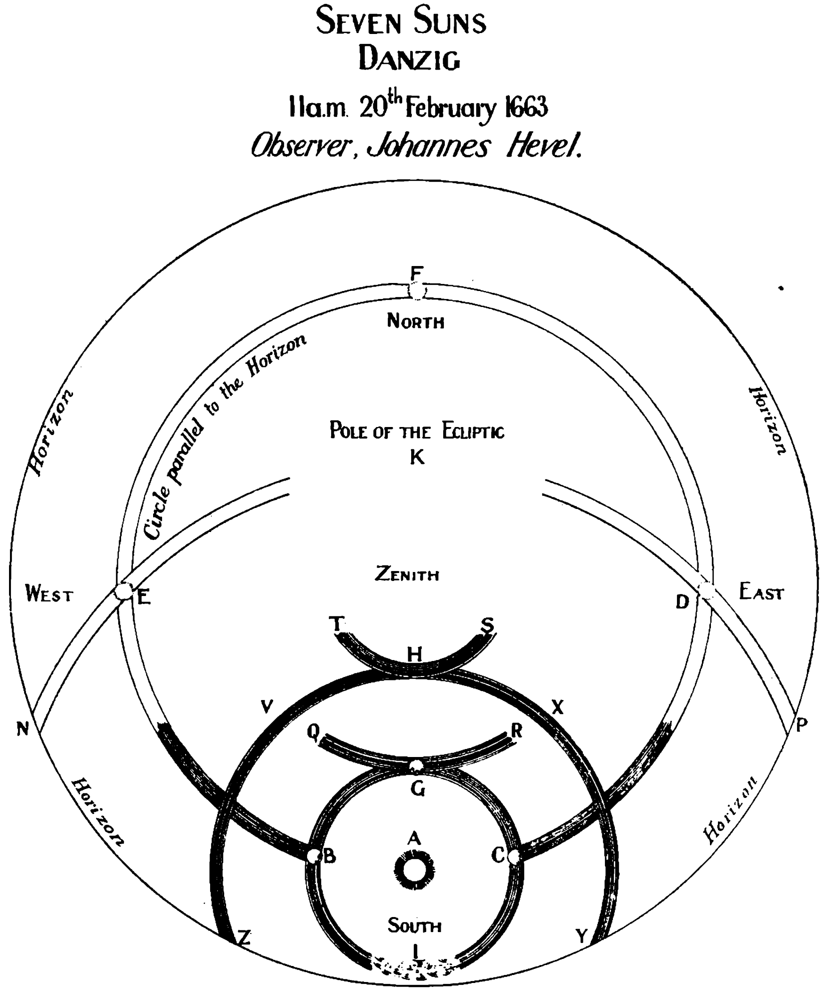


FIG. 12,

coloration depends on the brilliancy of the phenomenon, and when the intensity is feeble halos appear merely whitish. When seen, the colour of the edge of the halo nearest the sun or moon is red—a very pure red—while orange, yellow, and, under very favorable circumstances, green follow on as we go outwards. The green is always rather faint and whitish, and the blue which should appear outside of it is very seldom recognizable as such. Violet is never recognizable.

A ring of about twice the radius of the above, *the halo* of 46° VXYZ (Fig. 12) occurs more rarely, but is seen at times in Australia. Its luminosity is much less than that of the halo of 22°; the arrangement of colours, if visible, is the same.

Occasionally a colourless white ring, which passes through the sun parallel to the horizon, is visible. This is called the *horizontal circle, or mock sun ring.* It is represented in the figure by the circle CDFEB, in which the portion BC, which passes through the sun, is omitted. This is frequently, but not always, observed to be the case. It is unlikely that the complete mock sun ring is ever to be seen in Australia, but portions near the sun, and especially the mock suns where the halo of 22° crosses it, are occasionally recorded.

There are a number of halos which, from their method of formation, can only be seen as arcs. Among these are the so-called *arcs of contact*, of which two are shown in the figure. Both of these are arcs of upper contact. RGQ belongs to the halo of 22°. and is seen comparatively frequently in Australia, but the others are extremely rare. THS belongs to the halo of 46°. The convex side of the arc is turned towards the luminary. At the point of contact the arcs are often very luminous and brilliantly coloured, and some observers record mock suns there.

Of all halo phenomena, *mock suns* (*parhelia*) and *mock moons* (*paraselenae*) are probably the most admired. These terms are used to describe luminous or even brilliant patches, which are seen most frequently at or near the intersection of the halo of 22° with the mock sun ring (B and C, Fig. 12). Very rarely mock suns are faintly seen at the intersection of this ring with the halo of 46°. Mock suns are sometimes described as "images" of the sun, but this seems to be rather inaccurate. They are more often like brilliant bits of halo, and with the same colouration. Not infrequently mock suns are seen without any of the rings being observed.

We are not able to give here a comprehensive account of the possible halo phenomena, most of them being extremely rare in our latitudes. The figure shows those seen at Danzig on 20th February, 1663, as drawn and described by the astronomer Hevel. This was a very remarkable display.

Observers are requested to sketch and describe carefully what they see, giving angular measurements where possible. If precise instruments are not available, approximate methods should be used, such as by means of a stick, or the spread of the fingers when held at arm's length, &c. In making a sketch, the object should be not to produce a pleasing picture,

but to convey accurate information. The horizon line, and, if possible, prominent landmarks the bearings of which are known, should be included in the sketch. Photographs of any optical or cloud phenomenon of special interest are of great value if obtainable.

A very beautiful phenomenon, seen generally at sunset or sunrise, is the *sun pillar*. It usually extends as a narrow line for 10° to 20° above the sun in a vertical direction. In colour it varies from red to white, and is usually of a very delicate shade. Like the halo, the sun pillar is caused by reflection from the ice particles of cirrus clouds.

Corona. Solar Corona. Lunar Corona.—Coronae are most frequently noticed around the moon, but they occur, no doubt, at least as frequently round the sun. The brilliance of the latter, however, usually prevents the observer from looking directly towards it, so that it is only under exceptional circumstances that the corona is seen. By the use of dark glasses, or a poor reflector such as a glass surface, it may be easily observed.

In contradistinction to the halo, which is produced by refraction and reflection, the corona is produced by diffraction. The corona is usually a ring of smaller radius than 22°, though it may be as large or larger. It further differs from the halo in coloration, and may be definitely distinguished from it by this means. The corona invariably shows a *brownish-red* inner ring, which, together with the bluish-white area between the ring and the luminary, is called the *aureole*. Frequently the aureole alone is visible, and on these occasions the brownish coloration of the inner ring is especially marked. The brownish ring is much wider than, and its colour easily distinguishable from, that of the red ring of the halo. If other colours are visible, they follow the brownish-red in the order from violet to red, thus reversing the order in the halo.

A very large corona is sometimes produced when volcanic ash is present in the air, as is the case after violent eruptions such as that of Krakatoa. It is then called *Bishop's Ring*.

Coronae sometimes show their colour sequences several times over, which can never be the case with a halo. In recording a corona it is desirable to describe the colour sequence.

Brocken Spectre, or **Glory.**—If an observer stands in bright sunshine in such a position that his shadow falls on a near-by bank of fog or cloud, he will frequently see a coloured ring round the shadow. This ring is called a Brocken Spectre, or Glory. A white rainbow is sometimes seen at the same time, and is called *Ulloa's Ring*. From the nature of the case it is unlikely to be seen except on steep mountain ridges.

Iridescence.—Clouds sometimes display patches of brilliant iridescent colour. In Australia these colours can be seen very frequently in alto-stratus or high stratus cloud if only they be looked for, and brilliant effects are sometimes produced. Dr. G. C. Simpson considers that the iridescent patches are parts of coronae of differing radius. It is important to measure the angular distance from the sun, which often exceeds 20°. The radius of the corona is an index of the size of the water drops producing it, the smaller the drop the larger the radius.

Rainbow.—The rainbow is so well known that its identification presents no difficulty. The radius of the primary bow is about 42°, and the order of the colours is violet on the inside and red on the outside. A secondary bow is frequently seen, of which the radius is 12° greater than that of the primary, while its colours are reversed. There is considerable variation possible in the number of bows, their radii, the number of colour bands, and the colours and their sequences, according to the brilliancy of the illumination and the size of the drops. Rainbows always appear on the side of the sky opposite to the sun or moon.

Rainbows are caused by the moon in precisely the same way as they are by the sun. Owing to the feebleness of the light of the moon, however, the eye, as in the case of lunar halos, is seldom able to recognize colour in the *lunar rainbow,* which, therefore, appears as a white or yellowish arch. Under exceptionally favorable circumstances, colours may be seen, and, very rarely, brilliant displays are reported.

Bows formed in fog (**Fog Bows**) also frequently show no colour, owing partly to the low illumination and partly to the high proportion of diffused light.

Coloration of the Sky.—A cloudless sky appears to be blue, but the intensity may vary from deep-blue to almost white. The depth of colour will serve as an indication of the purity of the air. Sunset or sunrise lights also are interesting and worth studying, apart from their intrinsic beauty. Some observers have built up quite a system of forecasting from the appearance of the sky, and some of the phenomena certainly appear to give fairly reliable indications of coming weather. A soft rosy pink glow at sunset or sunrise, for instance, often precedes rain, while a greenish tint in the sky is regarded as a sign of dryness.

The Green Ray.—The very last glimpse of the sun as it is setting is sometimes of a very brilliant green. The colour is due to the unequal refraction of light of different colours. The green flash lasts only for from a small fraction of a second to a second or two, and is not likely to be seen unless the horizon is unobscured either by clouds or by hills, buildings, &c. It is therefore, most often seen at sea. Considerable controversy has centred round the green ray.

Mirage.—The position and appearance of distant objects are always altered to some extent by the refraction of the light which, passing from the object to the observer, has to traverse obliquely layers of air of different density, and sometimes the displacement of position or distortion of appearance is so great as to produce an illusion of apparent water, trees, or buildings. Such phenomena are conspicuous when the variations of temperature close to the ground are very marked, as when in desert countries the ground is strongly heated by the sun. The various types of mirage, and the theory of their formation, cannot be dealt with here, but mirages are worthy of note as affecting the visibility.

Aurora.—The nature of the aurora is not fully understood, but it is fairly certain that it is due to the discharge of electrified particles of some kind from the sun, or at least that it is stimulated by such a discharge. Australia is without the latitudes in which the aurora is seen at all frequently, but on exceptional occasions it is seen within 30° of the equator. These occasions usually coincide with a pronounced magnetic

storm, which itself is often associated with the passage of a large spot across the centre of the sun's disc. The *aurora australis*, or southern aurora, when seen in Australia, generally takes the form of a pinkish glow to the southwards. At times, however, an arch of light is seen over the southern horizon, from which streamers may play towards the zenith. Occasionally the streamers may appear bluish or greenish in colour, but this seems to be an effect of contrast with the general pink colour of the aurora. In exceptionally brilliant displays, the coloration may extend right to the zenith.

The aurora is an extremely interesting phenomenon from many points of view, and its occurrence should always be recorded. The light is not strong enough to be seen in the day time, but there is no more impressive scene than a good display at night time.

Zodiacal Light.—The zodiacal light is caused by an accumulation of matter in a state of very great tenuity centred round the sun and rotating with it. It has the form of an ellipsoid of revolution, the long axis lying approximately in the plane of the ecliptic. In simpler words, it may be said to be shaped somewhat like a bun lying in the plane of the earth's orbit. The illumination is probably reflected or scattered sunlight. It has the appearance of a pale diffused light extending from the sun back along the direction the latter has moved from, after sunset, or forward in its direction of motion before sunrise. It is not well seen in high latitudes, but in Australia, especially in the northern interior, it is a very prominent object, comparable almost in brilliance with the Milky Way. Its relative distinctness is a measure of the transparency of the air, and it is for this reason that it is recorded by some observers.

Crepuscular Rays.—Owing to the long dry spells during which dust and smoke accumulate in the atmosphere, crepuscular rays frequently present a most striking appearance in Australia, and their nature is often misunderstood. The phenomenon is due to the illumination of the dust particles by sunlight. When the sun is low, the shadows of clouds or mountain ridges will be thrown right across the sky, and as the particles in the shadow are much darker than those in the sunlight, the course of the shadow can be traced for varying distances. A series of alternately light and dark bands are thus produced. The bands are really parallel, but the effect of perspective is to make them appear to diverge from the sun. In brilliant displays the bands will even pass right across the sky and appear to converge, again from the effect of perspective, towards a point exactly opposite the sun. Crepuscular rays are seen at their best when appearing just after sunset. A popular description of the phenomenon is as " the sun drawing water ".

Phenological Observations.

Phenology is the study of the sequence of seasonal changes in nature. All natural phenomena, such as the first flowering of uncultivated plants, the migration and song of birds, ripening of fruits, the appearance of butterflies, caterpillars, insects, and so on, are included. Interesting results have been obtained from the study of these phenomena in England and the United States especially. Observers should include their observations of such happenings in the weather notes.

The Field Book, Register, and Return Forms.

The **Field Book** is the most important of the records kept by the observer, and is the ultimate authority for all data concerning the station. The need for keeping an accurate record has already been strongly emphasized, and is once more urged upon the observer. All observations, settings of thermometers, &c., should be made at the times designated. If, however, for any reason the observations are not made at the proper time, the actual time should be entered, and a note made of the reason for the departure. On no account should a false entry be made.

The **Register,** or the **Rain Register,** are provided to be kept at the station. They should be available as a source of information to local inquirers, and should be of interest to the observer himself. It is also essential for the registers to be kept in case the Field Book is lost in transit to the Weather Bureau, otherwise a month's record may be irrecoverably lost. The rainfall **Calendar** is also to be retained by the observer, and should be kept regularly entered up and exposed for public inspection in some suitable place.

The Monthly and Annual Returns, as well as the forms previously mentioned, are self-explanatory. Information regarding the frequency of occurrence of such phenomena as frost, hail, lightning, &c., is often wanted, and the observer is requested to record them carefully. All such entries are extracted from the returns and summarized at the Central Meteorological Bureau. It is desirable that the international symbols should be used for recording phenomena. This will shorten the work for the observer, and make the task of the official staff lighter. The Beaufort notation also may be used.

Entries in the Field Book should be made with a hard pencil, and should not be altered in any way. All other returns must be entered up in *black ink* in legible characters. Returns should be forwarded promptly on the completion of the period to which they refer. All the data called for should be given, and the observer should see that each column is correctly headed, making alterations where necessary.

The following additional points may be noted :—

Rain Day.—Any day on which one point (.01 inch) or more of rain is recorded is regarded as a rain day.

Days of Snow.—Any day on which snow has fallen, whatever the amount, is a day of snow. Similar remarks apply also to **days of hail.**

Snow on Ground.—The number of days of snow on ground is the number of days on which not less than half the ground was covered at the 9 a.m. reading.

Days of thunder are days on which thunder is heard, whether lightning is seen or not. The days on which lightning is seen, but no thunder heard, should be recorded separately.

Clear days are days on which the mean amount of cloud as observed at the fixed hours of observation is *less* than 2. On **days of overcast sky** the corresponding mean is *greater* than 8.

Days of fog should include only days on which the station was at some time surrounded by fog which was of at least moderate density.

Days of Frost.—At stations which have a grass minimum thermometer, a frost should be recorded if the temperature falls below 30.4° F. The frost should be ascribed to the day on which the thermometer is read. Where there is no minimum thermometer a frost should be recorded when frost has been seen in the near neighbourhood of the station.

Days of Gale.—A day of gale is one on which a wind of *force* 8 or more was recorded at any time.

PART II.

Self-Recording Instruments.

The advantages of a continuous record of the meteorological elements as compared with observations at isolated intervals will be obvious to all, and need not be discussed. The chief difficulties to be met in designing recording instruments are—(*a*) to secure a recording element which will give a record which either needs no correction or to which the corrections are simple ; (*b*) to have the scales, both for the phenomenon recorded and the time, sufficiently open to enable accurate readings to be made at any instant ; and (*c*) to keep the initial cost and the expense of maintenance within reasonable bounds. Most of the ordinary recording meteorological instruments contain a drum revolved at a suitable rate by clockwork, the record being inscribed on a properly designed form which is fixed on the cylindrical surface of the drum. In most cases the phenomenon is recorded indirectly, and the records need standardizing from time to time by the readings of an absolute instrument. To secure a suitable scale, it is nearly always necessary to magnify the changes that are taking place in the recording element, and this is most often done by means of a system of levers.

General Precautions.

The instructions which follow are of a general nature, and apply to most of the forms of recording instruments the meteorological observer is likely to have to deal with.

Dating, Storing, &c.

The time and the date (day, month, and year) of commencement and ending of a record should be marked in pencil on the form, preferably at the back, when the latter is put on and taken off respectively. As soon as possible after taking off, these data should be entered in *ink* on the form in the proper place. The name of the station and any other pertinent information must be added at the same time. If more than one instrument of the same kind is used at the station, the number of the instrument should be given. It must be remembered that the officer who ultimately has to deal with the record will probably be quite unfamiliar with the local conditions, will have large numbers of returns from different stations to deal with, and must depend for his information on the forms themselves. Forms should be protected from dust and rough handling and kept flat both before and after use. Should a record be missed in consequence of an accident (pen not marking, &c.), the chart should be filed with the successful records, and not be destroyed

or used again, otherwise a vain search is liable to be made at some time or other for the missing sheet. A defective record, too, may contain some valuable information. In the case of sunshine and rainfall recorders, the charts will often be blank, but these, also, should be dated and filed with the rest.

Care of Instruments.

All instruments should be kept clean and in good working order. Dust and dirt can usually be removed by means of a camel's hair brush, a clean soft linen rag, or a fresh wad of cotton wool. Chamois leather is often used, but is not recommended, because, unless frequently washed, it will collect dust, and delicate parts may be scratched. In moist climates and at coast stations it is frequently desirable to protect exposed parts by a thin coating of vaseline. The re-lacquering of parts from which the lacquer has disappeared is not difficult. The recording element of the thermograph, however, must be kept clean and bare, as any coating would reduce its conductivity, and therefore its sensibility to heat changes. Bearings, particularly of steel, should receive especial attention. The steel pivots of the gate suspension of the pen arm, for instance, should be kept slightly oiled.

Friction between the working parts of the apparatus must be avoided as far as possible. The bearings should be cleaned occasionally and oiled with good clock oil. Excess oil should be removed, as it serves only to catch the dust. The pen requires the most careful attention. It should be well washed from time to time in water or methylated spirits. A small brush is convenient for removing the caked ink.

A thin clear trace is aimed at, as it facilitates reading and prevents the blurring-out of slight variations which may be of great meteorological interest. A fine trace will not be secured unless the paper has a good surface. A paper which shows a tendency to absorb the ink can often be improved by ironing. The point of the pen must be fine but smooth so as to give a narrow trace without sticking to the paper. A new pen may frequently be improved by drawing the point once or twice along an oilstone, but any trace of oil should afterwards be carefully removed.

Excess of ink should be avoided, both because it may produce a blurred record and because it may overflow onto the metal style which carries the pen. Ink should never be allowed to come into contact with the style, as it will cause the pen to adhere firmly to the style so that it cannot be removed and cleaned. The ink may also cause the metal to become brittle and break. Should the style be accidentally inked, it should be immediately washed and slightly oiled. The pen should always be returned to the same position on the style.

The pressure of the pen on the paper should be reduced to the minimum consistent with an uninterrupted trace, for which simple contact with the paper will suffice.

Most modern instruments are so designed that the pen or the style which carries it is suspended like a gate, while the slope of the gate

bearings is capable of adjustment. Precise regulation of the pressure of the pen is then possible. The gate suspension of the barograph is seen at B in plate B, and the adjustment of the slope of the bearings is effected by means of the milled head O which clamps the rod carrying the bearing in any desired position in its cylindrical socket. Similar adjustments are provided for the pressure-tube anemograph, but the details are different.

In instruments in which the elasticity of the style is made use of to keep the pen in contact with the paper, the pressure should be adjusted by means of a milled head near the base of the style, so that the pen falls away from the paper when the instrument is tilted slightly.

The Charts.

In many instruments the recording pen is fixed to a lever, which is pivoted at one end so that the pen moves along the arc of a circle. The ordinates or hour lines on the charts supplied for such instruments are, therefore, also arcs of circles, and it is essential that the radius of the arcs on the charts should be equal to the length of the pen arm, and that the centres of these arcs should be at the same level as the pivot on which the pen arm turns. In other words, the curves traced by the pen when the clock drum is at rest should coincide with the arcs on the chart. It is for the instrument maker rather than the observer to attend to these points. In most instruments no provision for adjustment is made. Different firms, however, make instruments of different patterns, and the same firm may produce several types of the same instrument. Even if the drum is of the same size, the other features may be different, and it is necessary to see that the charts supplied are the correct ones for the particular instrument. When ordering a new supply of charts, the precise type of instrument, the maker's name, and, whenever it is given, the number of the chart should always be quoted, and a sample should accompany the order. The use of charts with arcs of wrong radius will throw the time scale considerably out, even though the range may appear correct. The width of the lower margin of the chart is also of importance. If it be too narrow or too wide the centres of the arcs on the charts will not be at the same level as the pivot on which the pen arm turns. The reduction of a trace drawn on a wrong or improperly adjusted chart is a very tedious business.

If the observer has any doubts as to the satisfactoriness of a chart he may test it by moving the pen across from the highest to the lowest position and observing whether the trace is everywhere coincident with or parallel to the arcs engraved on the chart. In order not to strain any part of the apparatus, the pen arm should be disconnected from the recording portion before this is done by removing one of the pins at some part of the system of levers by which the motion of the recording apparatus is communicated to the pen.

Should the ink have been allowed to reach the style of the pen, with the result that the latter is broken, a new style will be required. Too short a pen arm renders both time scale and range inaccurate.

When ordering charts for a sunshine recorder, care should be taken to state the latitude or range of latitudes in which they are to be used. Otherwise the charts may not be cut to the right dimensions.

The range of variation to be met with in the particular phenomenon recorded should be taken into consideration when ordering charts.

Fixing the Charts on the Drum.

The chart is held on the drum by a spring of some kind which grips both ends. It should not be put on loosely, but be everywhere in close contact with the drum. Assuming that the conditions referred to in the previous article have been fulfilled, the most important point is to see that the horizontal rulings are parallel to the base of the drum. If the chart is carefully cut so that its lower edge is parallel to the horizontal lines, this will be the case when the edge of the chart is in contact with the flange of the drum all round.

If the charts are not accurately cut, allowance should be made for the fact by eye. This may be done by seeing that the horizontal lines are continuous where the two ends of the chart overlap. In some instruments difficulties in this regard are avoided by having a fixed pen attached to the instrument, which will mark a horizontal base line on the chart. All measurements are then referred to this base line.

In mounting the chart, care should be taken to see that the spring does not cover a portion on which it is desired to secure a record.

Time Scale.

The accurate interpretation of the time scale is the most serious difficulty in the reduction of the records of recording instruments. The back-lash between the clock and the spindle on which it turns renders the accurate setting of the time scale a matter of considerable difficulty, and, in addition to this, errors in the clock rate or in the ruling of the charts, and also the effects of stretching due to changes in humidity, may introduce considerable uncertainty. The result is that many records, on which much time and money have been spent, are all but useless for scientific purposes. The difficulty may be avoided to a great extent by making time marks at known instants by slightly moving the recording pen. Most barographs are now fitted with a time marker (A, Plate B) for slightly depressing the pen arm, and so causing it to record a time mark. When this is not provided a mark may be made by gently tapping the instrument; but, if that be done, care must be taken not to shake the drum on its spindle or otherwise interfere with the record. In the case of thermographs and hygrographs there is no need for a special lever, as the pen arm can be easily moved from the outside. If the instrument is as free from friction as it ought to be, no discontinuity need be caused in the trace by the time marks. The absence of discontinuity in the trace furnishes good evidence that the instrument is working well.

If possible, time marks should be made punctually to the minute at a fixed hour every day, preferably at the time when the standard instruments are read. If this is inconvenient, arbitrary times may be selected and carefully noted correctly to the nearest minute. These times should be entered on the records before they are filed. Time marks should not be made until some time after changing the record sheets in order to allow the clock to take up the back-lash. The effect of back-lash or lost motion may be reduced to a minimum if the last motion in setting the drum is in the direction *opposite* to that in which it will subsequently move, and if this last motion is exercised with the minimum amount of force. In this way the drum is left in such a position that the clock motion immediately carries it on in the natural manner.

The rate of the clock should be adjusted if necessary by means of the regulator which will be found at the top of the drum. If the clock tends to lose its rate or to stop towards the end of the week, it should be wound regularly twice a week, namely, on Mondays and Thursdays.

In some observatories time marks are made automatically on all instruments by means of signals transmitted through a wiring system by a standard clock.

Interpolation.

The observer should satisfy himself that his instrument is working properly by frequently comparing its indications with the readings of standard or control instruments. In the ideal case the difference between the reading of the control and the value deduced from the curve is zero. In practice small discrepancies always occur.

We may distinguish three cases :—

(1) Where the difference is constant at all points of the scale, an error in setting is indicated.

(2) When the difference is zero at one point on the scale but increases proportionately on either side of this point, we may infer that the scale-value of the instrument does not correspond with that marked on the chart.

(3) Irregular variations are due mainly to friction in the working parts; lagging, structural defects, &c., produce similar effects. In practice all these cases may be combined.

If cases (1) and (2) are alone in question we may obtain accurate values for any intermediate epoch as follows :—

Let C_1 and C_2 be the curve readings corresponding to the fixed hour readings S_1 and S_2, taken on the standard instruments before and after the epoch in question.

Let c be the change shown by the curve between the fixed hour corresponding to S_1 and the desired epoch, and let s be the true change in the same interval,

$$\text{then} \quad \frac{s}{S_1-S_2} = \frac{c}{C_1-C_2}$$

$$\text{or} \quad s = c \times \frac{S_1-S_2}{C_1-C_2}$$

The value for s so found, when added to or subtracted from S_1 gives the true value required.

The irregular variations of the difference described under case (3) cannot be satisfactorily allowed for; they must be reduced to a minimum by a careful attention to the instrument.

Various diagrams have been devised to facilitate interpolation. Probably the most satisfactory method is to use a slide rule.

Ink.

Ink for Recording Instruments may be made from the following ingredients :—

Aniline colour	20 grammes.
Glycerine	250 cc.
Sugar	20 grammes.
Water	500 cc.

Heat the water and dissolve the sugar in it. Add the glycerine in small quantities, stirring the mixture thoroughly until each added portion is dissolved. Beat up the aniline colour in a small quantity of the solution, and stir the resulting mixture into the remainder of the solution, allow to cool, and the ink is ready for use.

The Barograph.

The motion in most barographs is furnished by a set of aneroid boxes (Plate B). The instruments used at official stations are of two sizes. We proceed to specify the dimensions of those parts of the apparatus which affect the size and ruling of the charts. These are—(1) the length of the arm carrying the pen, measured from pivot to pen point; (2) the height of the pivot of the pen-arm above the flange on the drum, against which the chart rests; (3) the magnification of the pen motion, i.e., the vertical distance on the chart corresponding with the change of pressure of 1 inch of mercury. The latter depends on the number and size of the aneroid boxes and on the arrangement of the levers. The horizontal distance on the charts corresponding with the interval of 12 hours is also given.

The dimensions are as follows :—

—	Large Instrument.	Medium Instrument.
Length of pen-arm	10·24in.	7·29in.
Height of pivot above flange	3·11in.	1·57in.
Magnification of mercury scale	2	1
Twelve hours on time scale	1·07in.	0·78in.
Diameter of drum	4·97in.	3·65in.

The scale usually reads from 28 to 31 inches. This range is sufficiently great to include all pressure values met with in Australia, if the instrument

be set to agree with the reading of a standard mercury barometer reduced to mean sea level, which is the most convenient setting.

Different devices for setting the position of the pen on the chart are adopted in different instruments. The standard method shown in the illustration is to adjust the height of the fulcrum of the principal lever C. by means of the milled head screw D. on the central bridge. In other instruments the adjustment is made by raising or lowering the point in the base plate to which the lowest of the set of aneroid boxes is fixed. This adjustment is made either by a milled head screw on the base plate near the aneroid boxes or by a screw or square head underneath the instrument.

Owing to the imperfect elasticity of the metal, barographs in which the motion of the pen is furnished by a set of aneroid boxes are subject to changes of zero. When absolute pressure values are required, their use must accordingly be confined to interpolating between the readings of standard mercury barometers. If the instrument is in good order, and if the pressure is changing slowly, the height of the barometer at any desired epoch may be determined as follows :—Having checked and, if necessary, corrected the time-scale by means of the time marks (see Fig. 13), read off from the curve the amount the barometer has risen or fallen since the previous reading of the mercury barometer was taken. Add this amount to or subtract it from the corrected reading of the mercury barometer. The result should be checked by working backwards from the next following reading of the standard. As a rule the difference between the two values so deduced will be slight.

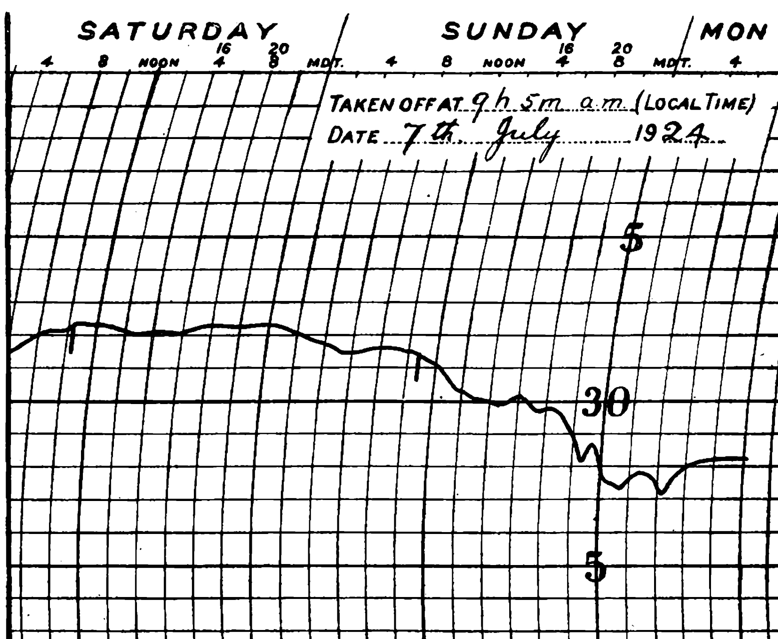


FIG. 13.

Suppose we wish to find the pressure at sea-level at 10 p.m. on Sunday, 6th July, 1924, from the barogram reproduced in Fig. 13. The time marks are at 10h. 0m., but the record shows that the clock was fast and gaining, so that the marks do not agree with the rulings. The pressures at sea level as derived from readings of the mercury barometer at 9 p.m. on Sunday and 9 a.m. on Monday were 29.947 in. and 29.871 in. respectively. Due allowance being made for the clock being fast, the curve readings for 9 p.m. and 10 p.m. on Sunday and 9 a.m. on Monday are 29.902, 29.858, and 29.823 in. respectively. That is, at 9 p.m. on Sunday the barograph was reading 0.045 in. and at 9 a.m. on Monday 0.048 in. too low. The best correction to the barograph readings is, therefore, the mean of these two readings, namely + 0.046 in. The reading at 10 p.m. Sunday is, therefore, 29.904 in. In a case such as this, the need for accurate timing is obvious.

A barograph, like an aneroid barometer, is subject not only to permanent changes in zero, but also to a phenomenon known as creep or hysteresis. Owing to the imperfect elasticity of the metal of the aneroid boxes, the instrument does not respond immediately and completely to the pressure changes, especially if these are large and rapid, but lags behind to some extent. Thus an instrument adjusted to read correctly at 30.5 inches, and then subjected to a diminution of pressure to 29.0 inches, followed by a rise to 30.5 inches again, will usually indicate something less than that value, and the difference may amount to several hundredths of an inch. If the pressure be now kept constant at 30.5 inches, the barograph will gradually attain that value after a few hours. In consequence of this phenomenon, the change of pressure in, say, 3 hours, as indicated by the barograph, may not only be incorrect in amount, but in certain circumstances may be in the wrong direction. Instruments issued by the London Meteorological Office are tested for creep, and are rejected if the error is excessive. A barograph should also be "compensated for temperature." A rise of temperature on an uncompensated instrument produces the same effect as a rise of pressure. This effect can be balanced by introducing a small quantity of air into the aneroid boxes.

Barographs are supposed to be compensated for temperature, but the compensation is not always perfect, so that a temperature curve is superimposed on the pressure curve. Furthermore, even if the temperature compensation is perfect, rapid changes will be taken up by the various parts at different rates, and errors in the trace are very likely. Large deviations are produced if the sun is allowed to shine on the instrument. A position should, therefore, be selected where the temperature will be as uniform as possible, and protected from sudden change. The instrument should also be placed on a firm support. An excellent cushion for a barograph may be formed with two pieces of rubber tubing.

When a barograph is being packed for transmission on a journey during which it may be subject to large variations of pressure, the pen arm should be released to prevent damage. When the instrument is to go to a very elevated station, special precautions should be taken to see

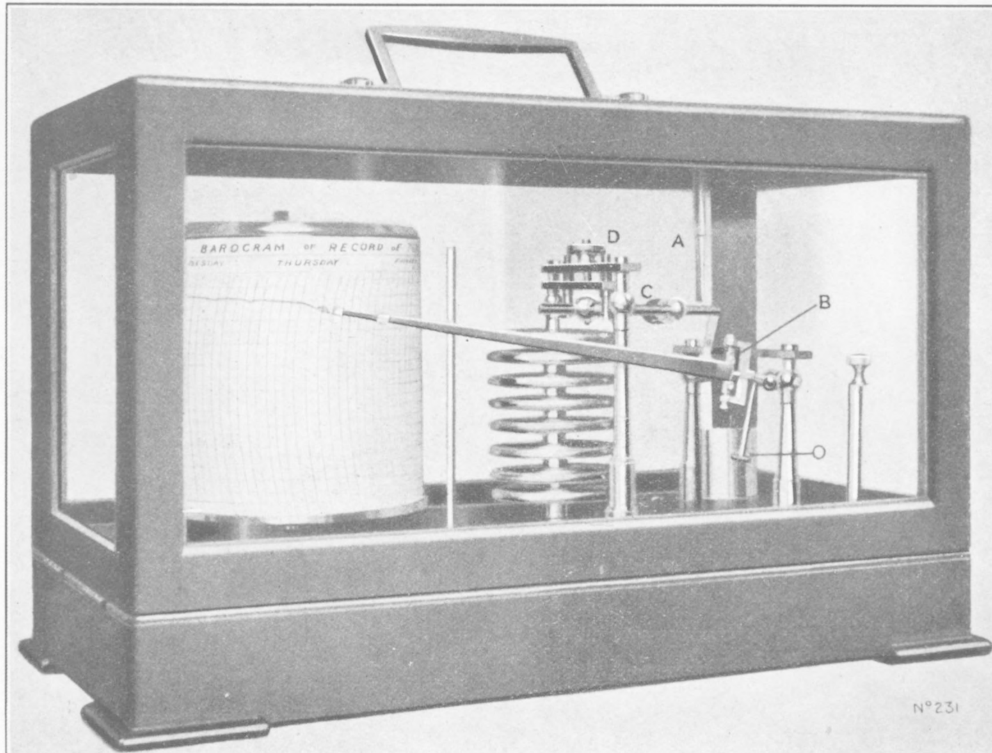


PLATE B.—LONDON METEOROLOGICAL OFFICE PATTERN MEDIUM BAROGRAPH.

[To face page 72.

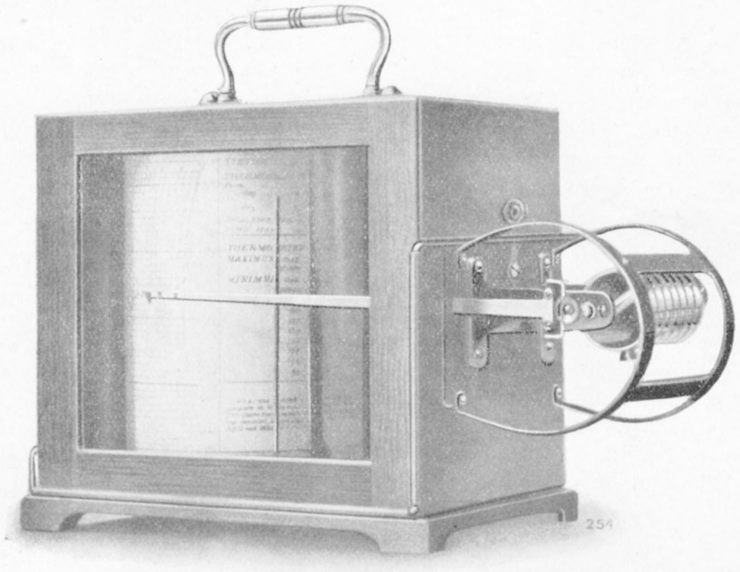


PLATE C.—LONDON METEOROLOGICAL OFFICE PATTERN BIMETALLIC-SPIRAL THERMOGRAPH.

[To face page 73.]

that the expansion of the aneroid boxes as the pressure falls can all be taken up by the system of levers. It may be necessary to disconnect these at some point.

The Thermograph.

In most thermographs the thermometer consists of a slightly curved metal tube filled with spirit (Bourdon tube), the curvature of which changes with change of temperature, or of a bi-metallic spiral, which coils or uncoils as the temperature changes. One end of the thermometer is fixed rigidly to the instrument, while the other is connected either directly or by levers to the recording pen.

From the nature of the case, thermographs for meteorological use must be exposed out of doors, preferably in a Stevenson screen, and hence it is necessary to clean and oil their bearings much more frequently than is the case with barographs, expecially in towns, where dirt accumulates rapidly.

The M.O. pattern bi-metallic spiral thermograph is issued with a clock drum for a weekly chart or a daily chart, as may be required. There is a device for altering the position of the pen on the chart, and so setting the instrument for different climates or different seasons. The setting may be accomplished by using the mechanism provided in the thermograph to adjust the indication of the new chart to agree with the reading of a mercury thermometer placed beside it in the screen. The change should only be made at times when the temperature is constant or changing slowly, and only when the pen is near the middle of its range. In most instruments there is no device for altering the scale, i.e., the amount of motion of the pen corresponding with a change of temperature of one degree.

The readings of the thermograph require frequent checking by comparison with control instruments. A convenient plan is to place a standard maximum and a standard minimum thermometer in the screen with the instrument, and to read and set these at regular hours, time marks being made at the hours of reading. It should be borne in mind that in cases where the trace shows that the extreme was of very short duration the sluggishness of the thermometers may cause an appreciable difference between the reading of the control and that of the recorder. It is not desirable to crowd a wet and dry bulb thermometer, a maximum and minimum thermometer, a thermograph, and perhaps also a hygrograph, into a Stevenson screen of ordinary dimensions. Such a course interferes with the adequate ventilation of the instruments We may either use separate screens for the various instruments, or construct a special screen similar to the ordinary one, but of enlarged dimensions. If the length of the screen be increased from 18 to 36 inches, the other dimensions being as specified on pp. 112 and 113, the four thermometers can be set up in the usual way in the middle part of the screen, with the thermograph and hydrograph on either side. A clear space of at least 3 inches should be left between the various instruments, or between the instruments and the louvres of the screen.

In addition to the type described above, various recording electrical thermometers have been used, the best known being the Callendar thermograph. These instruments are very satisfactory, and have the advantage that the recording portion may be located at a distance from the temperature element, say in an office room.

The Hair Hygrograph.

This instrument depends in its action on the fact that the length of a human hair, which has been freed from fat by boiling in caustic soda or potash varies with the relative humidity, but not with other meteorological elements. It increases in length as the humidity increases, and vice versa ; but the changes are not in proportion. A change of 5 per cent. in the relative humidity at the top of the scale, say from 90 to 95 per cent., gives a much smaller change in the length of the hair than

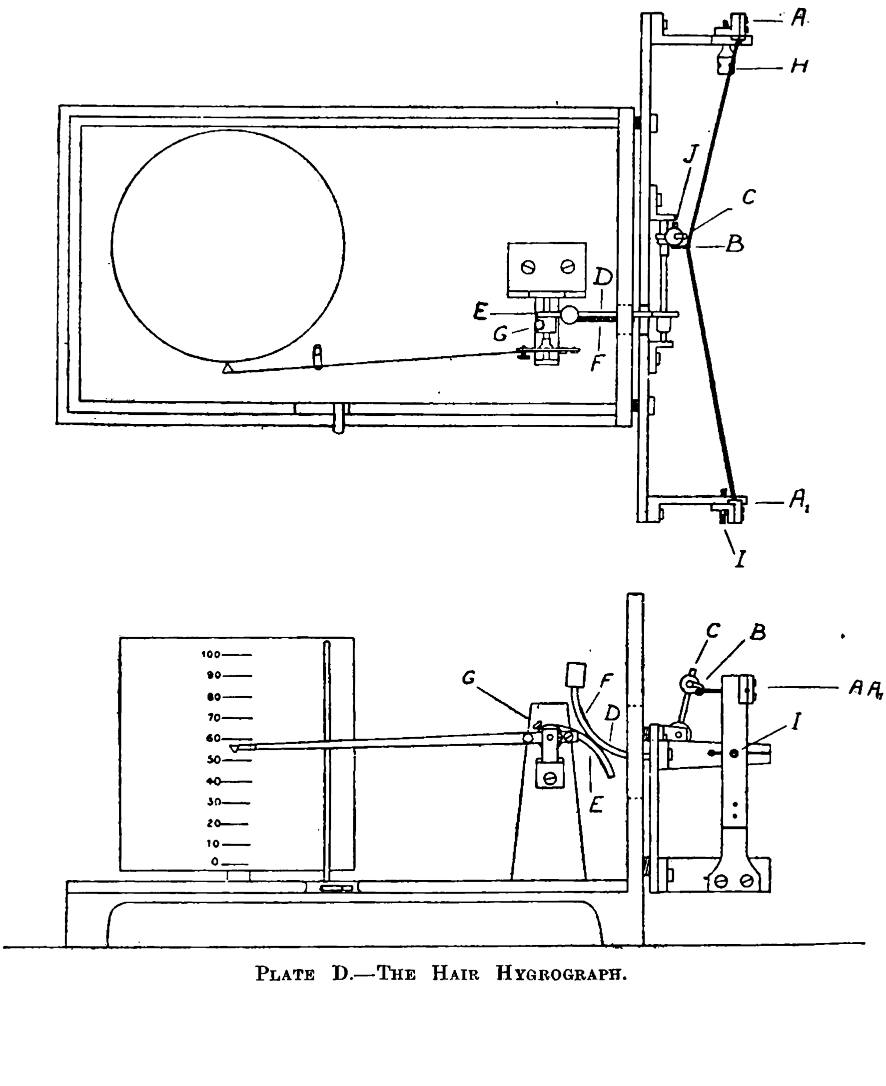


PLATE D.—THE HAIR HYGROGRAPH.

an equal change lower in the scale, say from 40 to 45 per cent. In practice, a small bundle of hair is used for actuating the lever bearing the recording pen. Some account of the Richard hygrograph, which is the instrument in general use in the meteorological service, is given below.

As is the case with the thermograph, the instrument must be exposed out of doors (in a Stevenson screen, see above), so that frequent cleaning and oiling of the bearings are necessary. After exposure to wind carrying salt spray the hygrograph reads too high. In these circumstances the hairs should be washed. Unfortunately, the properties of hair are subject to gradual changes, so that the reading is not always the same under the same conditions of humidity.

The instrument is shown in elevation and plan in Plate D, the wire cage and the case being omitted. The bundle of hair is held by the two jaws AA_1, and caught up at approximately its centre by the hook B. The horizontal axis of the lever C, to which the hook is fixed, is fastened to the cam piece D, which is just kept in contact with the sceond cam piece E by means of the light spring F. The second cam piece E is clamped to the pen arm axis by the screw G. Alterations in the length of the hair with humidity are in this way magnified and communicated to the pen. The greater part of the magnification of the changes in length of the hair is produced by the pen arm and the lever C, although some magnification is produced by the angle in the hair and by the cam pieces.

To keep the hairs in good order, they should be wetted once a week with a camel-hair brush. It is convenient to do this when the charts are changed. When the hairs have been thoroughly wetted, the reading of the hygrograph should be 95. It may be adjusted, if necessary, by turning the screw I by means of the key.

If an error in the scale value is suspected, calibration in an indoor room is desirable. As a standard, the ventilated psychrometer should be used. If one of these instruments is not available, ordinary dry and wet bulb thermometers may be set up and fanned. The humidity can be evaluated by the United States Weather Bureau Humidity Tables, or by the Nomograms M.O. London Forms 3093, 3094.

Adjustments can be made in the following way :—

(1) For zero error :—(*a*) Large adjustments for zero should be performed by moving the jaw A. This can be done by unscrewing the capstan-headed screw H. (*b*) Small adjustments for zero error (within 5 per cent. relative humidity on the chart) may be made by turning the screw I. Large alterations of the angle in the hair affect the magnification, and should be avoided.

(2) For scale value :—(*a*) The magnification may be very nearly proportionally increased or decreased by lowering or raising hook B on the lever C. The small screw J allows one to effect such a change. (*b*) The magnification may also

be varied by rotating the pen arm axis relative to the cam pieces. For this purpose the screw G may be utilized. Clockwise rotation of the pen arm decreases the magnification over the whole range of the chart, whilst anticlockwise rotation has the contrary effect.

A small secondary effect of clockwise rotation of the pen arm is that the magnification is decreased to a slightly greater extent towards the bottom of the chart than the top. Anticlockwise rotation has, of course, the opposite effect.

A little experience with a hygrograph will show that the humidity of the air frequently varies very rapidly, so that small errors in the time scale may become very serious. Accurate time marks are therefore very important.

For the same reason the comparison of the values of the humidity obtained from the curves with simultaneous values calculated from readings of dry and wet bulb thermometers is difficult. Sluggishness in either instrument may give rise to discrepancies. Another cause of difference lies in the fact that the reading of a wet bulb depends to some extent on the rate at which air is flowing past it. A single comparison is thus of little value, but on a long series of observations the mean difference between the readings should be small.

Self-Recording Rain Gauges.

Autographic rain gauges or pluviographs in common use are of three types :—

(1) Float gauges.
(2) Tilting bucket gauges.
(3) Balance gauges.

Whatever form is adopted, the scale value should be verified by pouring a measured quantity of water into the gauge. Its readings should also be checked by placing near it under similar conditions of exposure an ordinary gauge which is read once a day. In this way it will be seen whether the funnel collects the same amount of rain as does the ordinary gauge. The conditions which the exposure should satisfy are the same as those for the latter.

Float Gauges.

The gauges in use in the Australian service are of the Hellman-Fuess type, and are in two sizes, the 8-inch and the $6\frac{1}{4}$-inch (200 sq. cm. cross section).

This instrument is shown in Fig. 14. A gauge funnel of the usual pattern discharges into the brass receiver G, which contains a cylindrical float to which is attached the rod S carrying the recording pen arm P. The rod S and the pen arm are guided by the support U and the bracket B. To the end of P is attached a bearing wheel which runs along U.

A glass siphon tube L fits into a nickelled tube, which is clamped to the exit tube E in the side of the vessel G. The siphon empties into the can C. The drum T which carries the record is rotated by clock-work once in 24 hours.

The siphon is so adjusted that sufficient water is always left in the vessel C to lift the float off the floor, while at the same time the pen lies on the zero line of the chart. When water flows from the funnel into the receiver G, the float is gradually raised, carrying with it the pen, which thus records the amount. When 50 points of rain have fallen the water reaches the top of the siphon, which thereupon automatically empties this amount into the can. The record is checked by measuring the rain collected in the can with the ordinary measure glass. The amount will usually be a fraction of a point less than that recorded, as some of the water will be taken up in wetting the tube.

The lid of the receiver and the pen arm are easily rotated. When, therefore, it is desired to remove the drum, the pen is turned away and the drum lifted off the spindle.

The clock is designed to run for a week, and should, therefore, be re-wound every Monday morning when the instrument is attended to.

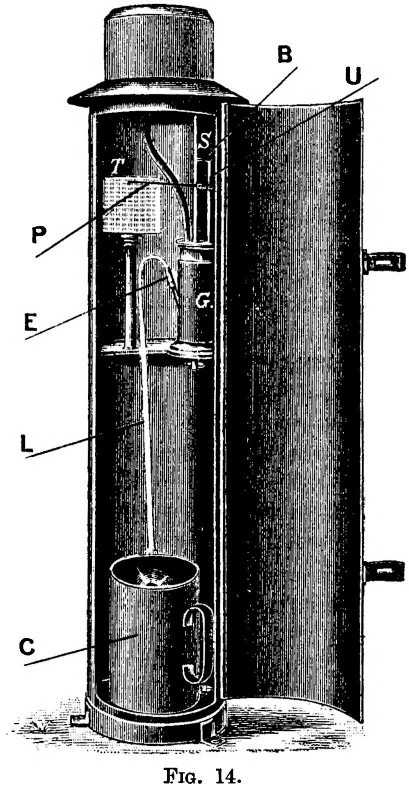


Fig. 14.

A spare siphon is supplied with each instrument to provide against breakage. The metal end should be covered with vaseline or oil before being placed in position. To test and adjust the siphon and pen pour water into the gauge until the siphon acts, when the pen should return to zero. If it does not, loosen the small screw which clamps it to the float, move the pen up and down until it rests at the zero mark, and re-clamp. Next pour water in the gauge until the pen marks 45 points. Then lift the siphon slightly out of the spout, pour in more water very slowly until the pen is floated up to the 50 point mark. The siphon should not have operated. If it has done so, it should be pulled further out and the process repeated. The 50 points having been poured in without any action of the siphon, the tube should be pushed slowly back into the spout until action takes place. Pour water in again, and see that the siphon releases each time when the pen is at 50 points. Now move the clamp on the nickel tube down until it rests on the top of the spout, then clamp tightly by means of the screw.

The above instructions refer to the larger instrument, which records continuously up to 50 points. In the smaller instrument, the receiver is designed to hold 40 points only, but the necessary modifications in the instructions will be readily understood. Especial care must be taken, however, to see that the measuring of the rain in the can C is done by means of a measure of the correct size. When setting up the instrument, it is necessary to see that it is accurately vertical. It is screwed by means of flanges provided for the purpose on to a firm wooden base, which should be built up to about 6 inches above the surface of the ground. The instrument is then securely stayed by means of the wire stays provided, which should come to the ground at an angle of about 45°. The stays are necessary in order to provide support and prevent vibration by strong winds. The door should open towards the least rainy quarter.

The gauge should be examined regularly to see that the tube has not been blocked by leaves, dust, or cobwebs.

The advantage of this type of pluviograph is that, while being accurate, it is very simple and robust.

When measuring up the traces, it must not be assumed that the siphon releases exactly at 50 points, or that the pen returns precisely to the zero. The actual amount recorded on the trace should invariably be measured.

After long spells of dry weather, it is well to pour water into the gauge, which will serve at the same time to test its working and to ensure that the float is not resting on the bottom through the water in the receiver being evaporated. The pen should be turned away from the drum during the process.

A more recent form of instrument, the **Hyetograph,** dispenses with the automatic siphon. The receiver is of sufficient capacity to hold a rainfall of 100 mm., and the float rises continuously through a height corresponding with this amount of rain. When the pen reaches the top of the drum, which in most instruments will be the case after a centimetre (or half an inch) of rain has fallen, an arrangement comes into play automatically whereby the pen arm falls back to zero. A hand siphon serves to empty the gauge when necessary.

When working with float pattern gauges, attention should be paid to the following points :—

(1) Sticking or jamming of the working parts must be guarded against by cleaning the instrument from time to time. Want of level is also frequently the cause of sticking.

(2) The amount of water left in the cylinder after a discharge must be sufficient to lift the float off the base of the cylinder. If this is not the case a small amount of water will have to collect before the float begins to rise.

(3) After each operation of the siphon the pen should return to the zero of the scale.

(4) The discharging siphon, or the catch that allows the pen to return to zero, must be regulated to come into action as the pen reaches the top of the chart.

Tilting Bucket Gauges.

In these instruments the rain water passes from the collecting funnel to the "tilting bucket," in which it is measured. The latter consists of an elongated flat-bottomed trough with open ends, which is divided into two parts by a central transverse partition, and pivoted about its central point like the beam of a balance. When the left-hand end of the trough is depressed, the rain water is collected on the right-hand side of the partition. The balance is so adjusted that the weight of the water collected causes the bucket to tilt over as soon as it reaches the amount of .01 inch, or, in more sensitive instruments, .005 inch. This tilting causes the water to flow from the bucket into a small receiving funnel, whence it passes to a collecting vessel or runs away. If rain continues to fall, it is now received in the trough on the left-hand side of the partition until another .01 inch has fallen, when a second tilt will occur.

The instrument is made autographic by arranging for each tilt of the bucket to raise an arm bearing a pen, which records on a revolving drum, through a short step. The height through which the pen is raised is thus proportional to the amount of rain which has fallen. A simple arrangement allows the pen to fall back to the zero of the scale when it reaches the top of the drum. If desired, the tilting bucket and the recording apparatus may be put in separate cases and connected electrically. With this form of apparatus the gauge may be suitably exposed while the recorder is placed within doors in any place that happens to be convenient. It will be perceived that the record is not continuous; each step on the chart corresponds with a fall of .01 inch during the interval between it and the previous step.

This type of gauge gives fair results for heavy falls, but it is useless for measuring the duration of gentle rain. On account of evaporation, light falls may be seriously underestimated.

Balance Gauge.

A third pattern of autographic rain gauge depends on the principle of maintaining the equilibrium of the receiver by a curved lever bearing a weight. As water accumulates in the receiver it sinks at a rate proportional to the rate of rainfall, and when full it empties automatically, either by the inversion of the vessel or by the agency of a siphon.

Note: to determine actual rainfall when rain in 8" gauge measured in 5" measuring glass.
Let x = the no. of pts. measured in 5" gauge.
then real amount = $x \times \frac{25}{64}$ "
= correct rain in pts. for 8" gauge.

Anemometers.

The question of exposure enters into all matters connected with the measurement of wind to a very large extent, so much so that it may, without exaggeration, be said that the exposure is of more importance than the actual instrument. At many stations the orographical features are such that the provision of an anemometer is not to be recommended, unless it be intended to investigate such special points as the effect of the configuration of the land on the wind.

The site selected for the instrument should be such that it is not sheltered by trees or buildings, and it should be remembered that the eddies caused by such obstacles extend both vertically and horizontally to great distances. People are very apt, too, to forget that trees grow, so that a site once favorable does not necessarily continue so. In a perfectly open and flat situation, a scaffolding some 30 feet in height affords an excellent exposure.

Anemometers may be divided into three main types :—

(1) Windmill anemometers.
(2) Pressure tube anemometers.
(3) Pressure plate anemometers.

Instruments of type (1) give readings almost independent of air density. In types (2) and (3) the density is an important factor, and allowance for its variation should be made when such instruments are adopted for use on aircraft, or even at high-level stations.

The Cup Anemometer.

The cup anemometer consists of four hemispherical cups attached to the ends of two crossed metal arms. The cross is pivoted at its central point in such a way that it is free to rotate in a horizontal plane. The difference of pressure of the wind on the convex and concave surfaces of the cups causes the cross to spin round.

The number of revolutions of the cups in a given time is usually assumed to be proportional to the amount of wind which passes them, though this assumption is not strictly justified. The ratio of the distance travelled by the wind to the distance travelled by the cups is known as the " factor " of the anemometer.

At each of the Weather Bureaux is installed a " Kew pattern " Standard Robinson anemometer with 9-in. cups and 2-ft. arms arranged to record electrically, every 5 miles run of the wind being recorded on a chronograph. For this instrument the factor 2.2, recommended by the Wind Force Committee of the Royal Meteorological Society in 1904, is used. Recent investigations have shown that the factor really depends on the speed. For the standard pattern with 9-in. cups the factor is approximately 3 at 2 m/s, 2.5 at 5 m/s, 2.2 at 9 m/s, and extropolation indicates that the factor would be 2 at 25 m/s. The following table

will indicate the order of accuracy given by the assumption of the constant factor 2.2 :—

——	Metres per Second.							
Tabulated Wind (assumed factor 2.2)	1	2	4	6	8	10	12	14
True Wind	1·5	2·7	4·7	6·5	8·2	9·9	11·6	13·4
Tabulated Wind from formula W= 1.93 R + 1·15 m/s	2·0	2·9	4·7	6·4	8·2	9·9	11·7	13·4

The last line gives the winds which would result from the use of the factor 1.93 with the addition of 1.15 metres per second in each case, which obviously gives a much better result. In miles per hour the equivalent formula would be $W = 1.93\ R + 2.6$ m.p.h. where W is the true wind and R the run of the cups. A formula of this kind appears to give good results with other types of cup anemometer.

The anemometer can conveniently be made to record on the same sheet as the barograph.

A smaller type of electrically recording cup anemometer used in Australia has cups of 4 inches diameter and an arm length of 6.72 inches. For this, the factor 3.0 is used. This anemograph is made to record also the direction of the wind to the nearest four points (i.e., to 8 points of the compass) once every 15 minutes. This is accomplished by means of a vane which carries a spindle, to the end of which is attached a brush which covers an arc of 45°. The brush works over a commutator consisting of four segments corresponding to the north, east, south, and west quadrants. The vane sets in the direction of the wind, and communicates its motion to the brush. If the wind is north, the brush lies wholly in the north segment of the commutator, and when the circuit is automatically closed by clockwork at the end of a 15 minutes interval, the recording lever connected with the north segment will be depressed and make a record. If the wind is north-west, the brush will be in contact with both north and west segments, and both north and west pens will be actuated when the current is closed. The instrument is rather complicated, and its results are scarcely of sufficient refinement for modern requirements.

Another much used anemometer has 3-in. cups and 7⅜-in. arms. Instruments with these dimensions are adapted to record either electrically or by means of a dial. The conversion factor used is 2.73, and, according to the following table, which is copied from the *Observers' Handbook* for 1921, and refers to tests of M.O. 90 at the National Physical Laboratory, it gives satisfactory results over a fairly long range of velocities :—

Instrument reading.	mi/hr.	5	10	15	20	25	30	35	40
True Wind Speed	mi/hr.	5·8	11·0	15·8	20·2	24·2	28·1	31·7	35
	m/s	2·6	4·9	7·2	9·0	10·8	12·6	14·2	15·6

It is not possible here to give any detailed description of the various types of Robinson anemometer, nor precise instructions for the use of any particular one. A few hints of a general nature may, however, be given.

All bearings, especially the gear wheels of the counting mechanism, should be cleaned and oiled at least once a month. When rotated by hand at the rate of one turn per second in a calm (e.g., inside a room), the cups should continue to spin for at least 60 seconds.

In the electrically recording types the battery should be examined and tested frequently, to see that all connexions are right, and that the power is sufficient to work the recording parts.

The standard exposure of an anemometer is 10 metres (33 feet) above the ground at the top of a mast or a skeleton tower, and well removed from all buildings and trees. If such an exposure cannot be obtained, the anemometer should be not less than 10 feet above the top of buildings and trees in its neighbourhood. The ridge of a steep roof should be avoided, as it tends to deflect the wind upwards, and produces eddies.

The variation of the direction and velocity of the wind with height varies according to a number of conditions, such as the nature of the surface, the strength of the wind, the temperature, and the lapse rate of temperature. In Europe the wind at 10 metres is approximately half the gradient wind.

The Air Meter.

The air-meter works on the same principle as the ordinary windmill. The "sails" are light vanes attached to the spokes of a wheel. These vanes are flat, and they are set to make a definite angle (usually about 45°) with the plane of the wheel. There is an arrangement for counting mechanically the number of revolutions of the wheel, or some multiple thereof. This multiple is chosen so that the number shown on the dial may represent as nearly as possible the "run" of the wind in convenient units.

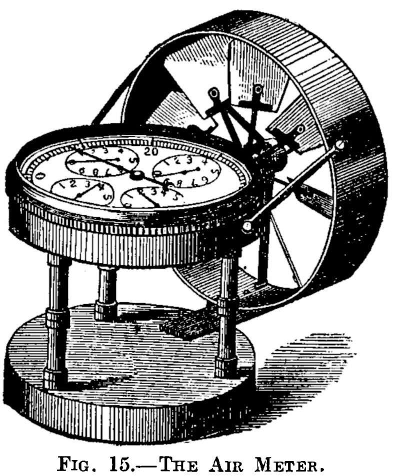


FIG. 15.—THE AIR METER.

The most satisfactory test of the accuracy of an air-meter is in a wind-channel; but similar instruments can be compared with advantage in the open air. It is found that the assumption that the "run" of the wind is proportional to the number of revolutions at all speeds is not seriously in error. The corrections to the readings may be less than 2 per cent. throughout the range from 10 ft./sec. to 50 ft./sec.

Fig. 15 shows a portable air-meter. In this model the diameter of the fan wheel is 2½ inches.

An air-meter of this type may serve to determine wind direction. It is placed by hand in such a position that the wheel shows no preference for turning in one sense rather than the other. The fan wheel then lies in the direction of the wind, and its axis at right angles to it. When the direction of the wind is known, the air-meter is placed facing the wind, and the speed is determined by measuring the run in one minute. Air-meters are frequently used in mines and other places for measuring ventilation currents. Their portability and accuracy render them useful for many purposes. They are convenient for measuring the velocity of an air current at any particular spot, but, owing to the impossibility of properly exposing them, are not suitable for ordinary meteorological requirements.

The Dines Pressure Tube Anemometer.

Undoubtedly the most satisfactory anemometer at present on the market is one of the variations of the Dines Pressure Tube Anemograph, designed to record both velocity and direction. The pattern made by Munro has a number of advantages over some of the others, and a description of it will be given.

The standard mounting of a tube anemometer is with the vane 40 feet above the ground. When the instrument is provided with a direction recorder, the mast may be supported by a skeleton tower, which does not interfere appreciably with the flow past the vane. When a site well away from trees or buildings cannot be secured, the vane should be at least 20 feet above them.

The Head.—(The head and connexions are shown in the upper part of the diagram in Fig. 16.)

The vane is fairly large and stout, in order to secure sensibility in recording the direction. It is rigidly connected by means of brass tubing to the working part of the direction recorder in the room below. The vane with its attached tubing is supported on the head by ball bearings.

The front portion of the vane consists of a tube which is open to the air at the point A. The action of the vane keeps the opening A pointing to the direction from which the wind is coming. The wind blowing into A produces an increase of pressure in the tube, which is transmitted down the centre of the head to the outlet P, which communicates by means of flexible metal tubing with the recording apparatus below. The inner fixed pressure tube in the head is surrounded by an outer tube, in which, at S, there are four rows of perforations. The wind blowing past these causes a suction effect, and a consequent diminution of pressure in the outer tube, which is communicated through the outlet T through flexible tubing to the recorder. The flexible pipes may be of considerable length, say 40 or 50 feet.

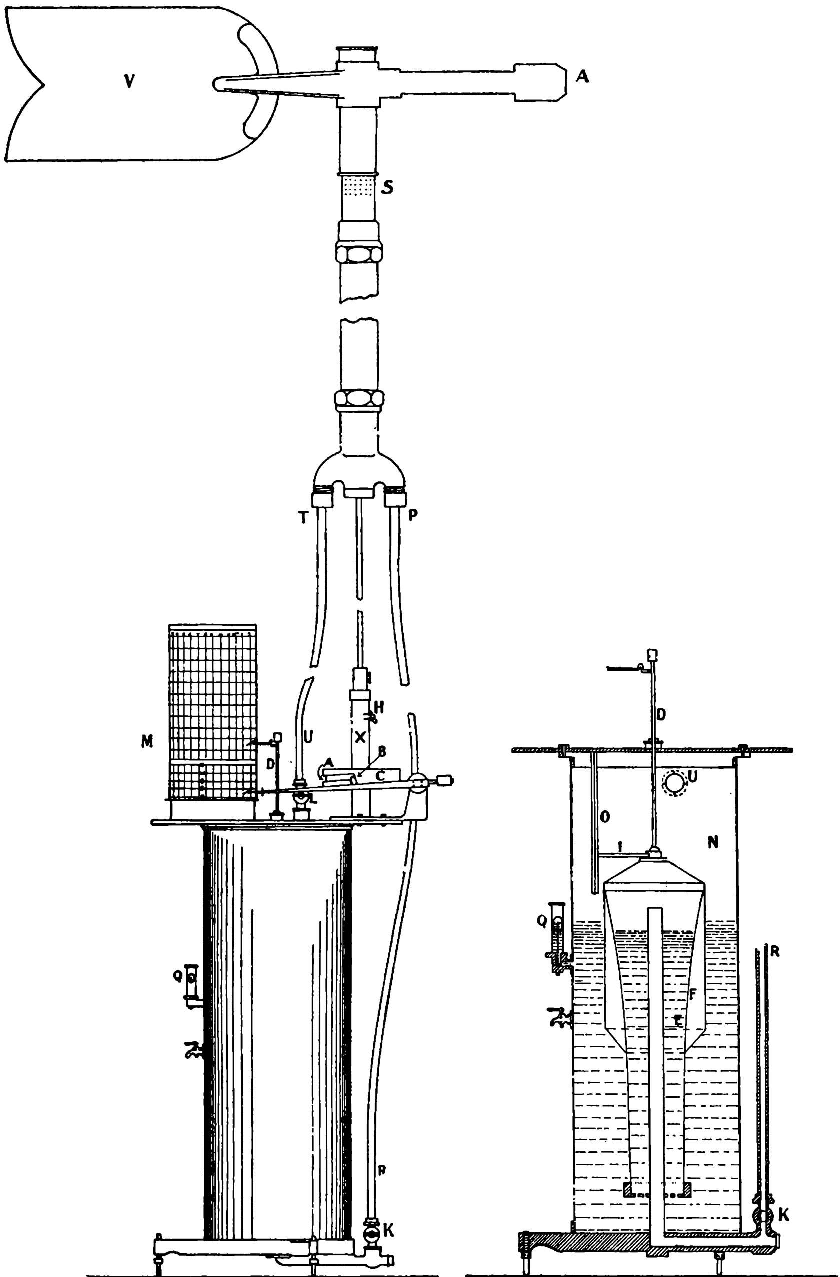


FIG. 16.—DINES PRESSURE TUBE ANEMOMETER.

The provision of the suction tube has the double advantage that it increases the sensitiveness of the apparatus, and at the same time prevents any vitiation of the results by changes of pressure in the recording room which might be produced by strong gusts of wind.

When setting up the head, care must be taken that the axis about which it rotates is vertical, and that the flexible pipes have a fall throughout, so as to prevent the lodgment of water. The head requires occasional cleaning, especially in places where there are insects which build nests in small cavities. No oil should be used on the bearings.

The setting of the vane in the wind may be tested by attaching streamers to the tube below it and seeing if the vane sets parallel to them.

The vertical tubing attached to the vane is clamped at its lower end to the spindle of the recorder by means of two screws. It is important that they should be clamped exactly in the correct relative orientation in order to avoid systematic errors of direction. This can best be done by setting the vane in the cardinal directions, and seeing that the pen of the recorder reads correctly. The readings should be made with the vane moving both clockwise and counterclockwise, so as to see that there is no lost motion anywhere. Should there be any difference between the readings, the vertical tube should be examined to see that there is no looseness at the joints, and that it hangs freely throughout its length. In the Munro instrument the pen moves from top to bottom of the direction chart as the north point is passed. The angle over which the change is taking place covers about 10°, and the break should be symmetrical about the true north. The correct position of the recording spindle and cam relative to the vertical tube having been found, they should be firmly clamped in this position, and need only be re-tested at rare intervals.

The Direction Recorder.—The direction recorder is shown in the lower left-hand diagram of Fig. 16. It is screwed on to the top of the vessel containing the velocity recording apparatus. It consists of a brass spindle X, turning freely on its axis, which carries a circular cam C, on the rim of which a helical groove A is cut. The radius of the cam to the bottom of the groove is 2 inches. A projection on the lever arm of the recording pen, carrying a bearing wheel, fits into the groove. The pen is at its lowest point on the chart when reading a little east of north. As the cam is rotated through east, south, and west towards north again, the pitch of the groove carries the pen up the paper. When near the north position, the projection on the pen arm reaches a portion B of the groove with a much steeper pitch in the opposite direction to the remainder, down which it falls to the original position. If the spindle is rotating in the opposite direction, the reverse process takes place, and the pen arm is carried up the groove B. As it passes from top to bottom, or vice versa, a bevelled steel piece in B deflects the pen arm outwards, so that the pen is lifted from the paper, thus avoiding splashing or blurring of the record.

The Velocity Recorder.—The velocity recorder consists of a float F, shown in section in the lower right-hand diagram in Fig. 16, which is placed mouth downwards in a closed tank N, partially filled with water. The flexible tube from the pressure head connects with the tube R, which communicates with the air space above the water in the float, while that from the suction head leads through the tube U to the space above the float. A wind blowing past the vane thus produces an increase of pressure inside and a decrease of pressure outside the float. Both tend to make the float rise by an amount depending on the velocity of the wind. A record of the motion of the float is thus a record of the wind passing the head.

The apparatus has the advantage over cup anemometers that it indicates changes in wind velocity almost instantaneously, and gives a record of the fluctuations during gusts, and not merely the mean velocity for a given interval.

To the top of the float is attached a vertical rod D, which passes through what is practically an air-tight collar in the cover of the tank. This rod carries a pen which records on a drum, M, rotated by clock-work once in 24 hours. To the rod is attached a guide I, which moves in a vertical slot O, and so prevents the float from rotating.

The shape of the inner surface E of the float is of great importance. It is so constructed that the displacement of the recording pen from the zero of the scale is directly proportional to the velocity of the wind at the head.

When adjusting the apparatus it is necessary that the air pressure should be the same on both sides of the float. To effect this two three-way stop-cocks, K and L, are provided, which enable the tubes leading to the head to be closed, while the air spaces above and within the float are in communication with the air in the room.

In the management of the instrument, attention should be directed to the following points :—

(1) The instrument should be kept clean, so as to permit of the free working of all its parts. It is especially important to keep the rod D free from oil, verdigris, and grit. It may be raised as high as it will go, and polished with a little black lead.

(2) It must be kept level. To test the level, remove the collar through which the pen rod passes, and note whether the latter passes through the centre of the hole in the top of the tank. If not, adjust by means of the levelling screws. Replace the pen carriage on the rod before making the adjustment. The foot-screws should bear on a metal surface, and not on wood.

(3) The level of the water in the tank should be kept up to the fixed mark in the gauge Q which projects from the side.

(4) When both taps are turned so that communication with the head is shut off, the inside and outside of the float thus being in communication with the air of the room, the

float should remain with the mark on the stem just flush with the top of the collar through which it passes. If the adjustment is not perfect it should be corrected by adding or withdrawing shot from the cup on the pen carriage.

(5) The pen can be adjusted to the zero of the chart whilst the mark on the stem is held flush with the collar.

(6) The pen should slope slightly towards the drum, in order to ensure a regular supply of ink. The prongs of the pen should press equally on the paper.

(7) From time to time the pressure tap should be opened while the suction tap is closed, and vice versa, to see if both suction and pressure are working. The velocity shown with pressure alone is about five-sixths of the correct reading, with suction alone about one half.

(8) In the Munro instrument the direction recorder can be put in or out of gear by means of a catch (H in the figure). It is a good practice when changing the paper each morning to move the drum to and fro for a short distance when the taps are open to the air of the room, and when the direction pen is in each of its extreme positions (the spindle being released from the head). In this way the correctness of the velocity zero and of the direction readings will be indicated on the chart, and allowance can be made for any error when the measuring up is done. It is, of course, important that the chart should be fixed in the correct position on the drum.

An improved form of vane has been designed recently which has a rectangular vertical blade of "stream-line" cross section on a comparatively long arm. This form has given excellent results, and appears to be practically dead beat.

The Anemobiagraph.

The head of the anemobiagraph is identical in principle with that of the Dines anemometer. The float of the recorder is cylindrical, however, and its motion is controlled by springs. In place of pure water, a mixture of water and glycerine with a little colouring matter is used, so as to minimize the risk of freezing. Any variation in the specific gravity of this liquid from its standard value, 1.16, alters the zero, but not the scale value of the record. The instrument is calibrated according to the Dines formula. It may be noted that, as the float is acted on by springs as well as by hydrostatic forces, the level of the liquid in the float-chamber is variable when the anemometer is in action. The level

is adjusted with both taps open to the air of the room, i.e., at the zero of the record. There is no shot cup for adjusting the weight of the float, and the recorder is insensitive to small changes of level of the liquid.

Pressure Plate Anemometers.

A number of anemometers have been designed in which the wind is measured by the pressure it exerts on a plate. The majority of these are not satisfactory, and none are in general use.

Perhaps the best type of pressure plate anemometer is that designed by H. A. Hunt, and described in a publication of the Commonwealth Meteorological Bureau. The instrument does not, however, set into the wind very satisfactorily, and requires considerable attention. It has never been put on the market.

The Campbell-Stokes Sunshine Recorder.

The sunshine recorder most commonly used is the type devised by Mr. Campbell, of Islay, and modified by Sir George Stokes. All instruments used in Australia consist of one or other of the variations of the Campbell-Stokes design.

The instrument makes use of the fact that a glass sphere will bring the sun's rays to a fairly sharp focus at a certain distance from it, and that the heat developed at this focus is sufficient to burn the surface of a paper card placed there. The obvious advantage of the sphere is that there is no need to change its position with the changing daily and seasonal motions of the sun, as would be the case were a lens of the ordinary form used. All that is necessary is to have the record card suitably placed on the sphere, concentric with the glass one, on which the sun is focussed. Fig. 17 shows the design at present being installed at Australian stations.

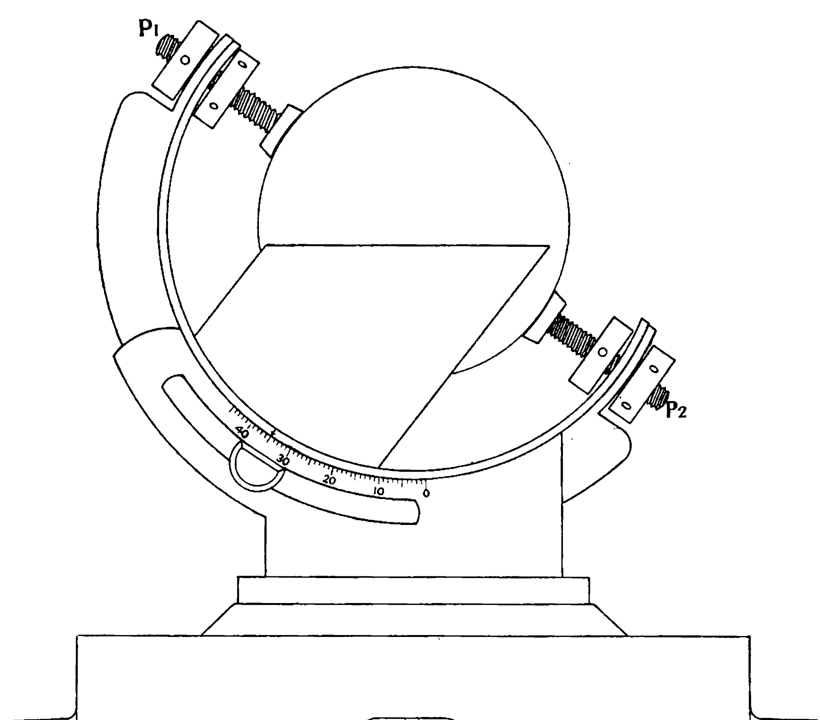


FIG. 17.—CAMPBELL-STOKES SUNSHINE RECORDER.

Exposure.

It is important that all sunshine should be recorded, so that the exposure should be such that at no time of the year are the sun's rays cut off from the instrument by surrounding objects. The diagrams of Fig. 18 will indicate the altitude and the azimuth or true bearing of the sun for different times of the day in various latitudes and seasons. As the latitude decreases, the sun moves in a more and more nearly vertical direction when at low altitudes, and consequently covers a smaller range of azimuth in the course of the year. The difficulty of securing a free exposure of the sunshine recorder, therefore, decreases as the equator is approached. If the horizon is clear between NE. and SE. on the east side and NW. and SW. on the west side, that will be sufficient in any part of Australia. No obstacle to southward of these directions is of any consequence. To the north objects of moderate altitude will cause no obstruction. In cases of doubt the diagrams of Fig. 18 should be consulted.

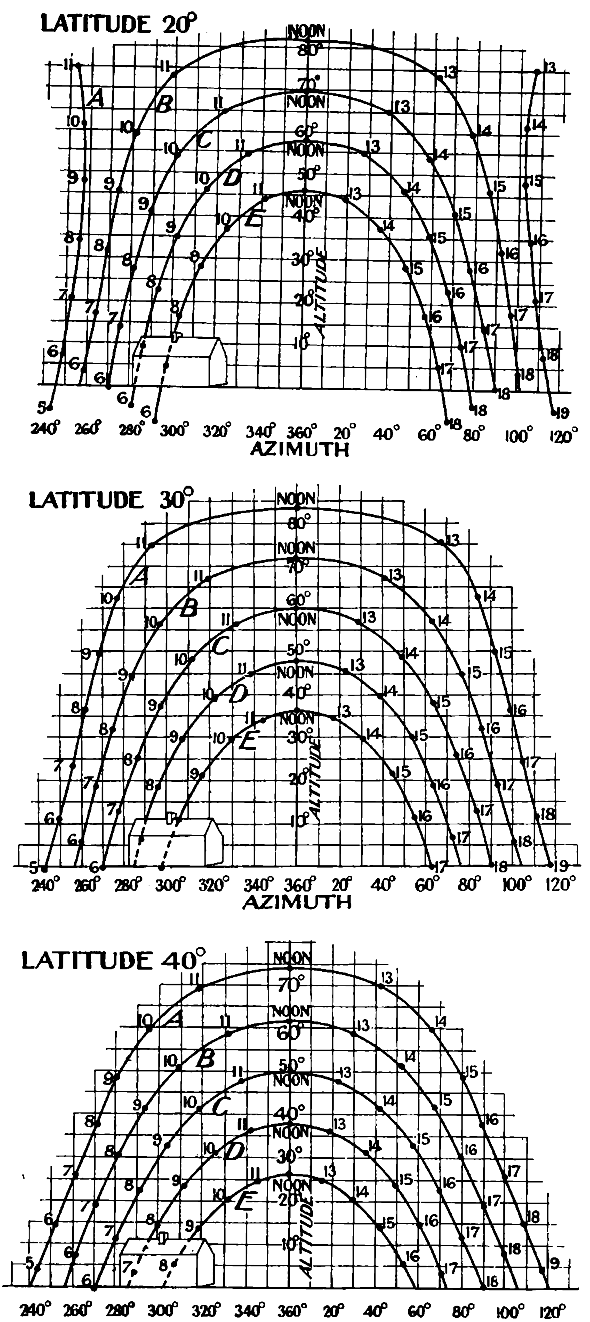


Fig. 18.

During the year the sun moves from its southernmost position on the tropic of Capricorn northwards across the equator to the tropic of Cancer and back again. The angular distance of the sun from the equator is called its declination. The declination, therefore, varies between 23½° South and 23½° North. The diagrams of Fig. 18 give the sun's altitude and azimuth at any time of the day for latitudes 20°, 30°, and 40° South at the summer and winter solstices, the equinox, and for positions midway between.

The exact hours are marked on the curves. The times are, of course, local apparent times. Azimuths are reckoned from north round by east through 360°.

If it is not possible to secure an absolutely uninterrupted exposure, the amount of sunshine cut off at various periods of the year should be calculated from the diagrams, and allowed for in preparing statistics for a station. For practical purposes, the horizon may be regarded as free if it is so to within three degrees of the true horizon, as at lower altitudes the sun is too feeble to burn the card.

The sun's declination is given in the *Nautical Almanac* and in numerous other publications, including *Whitaker's Almanack.* Having found the declination for any date, it is then possible to interpolate a curve corresponding to the particular declination between the curves given in the figure on either side of it. The noon altitude is equal to the colatitude (90°—latitude)—the sun's declination, the latter being counted positive for north and negative for south declination. In a similar manner interpolations can be made for latitudes other than those shown. The following table gives the dates and declinations for which the curves of Fig. 18 apply :—

	Sun's Declination.	Curve.
22nd June, Solstice	23½°N. ..	E
21st April and 23rd August	11¾°N. ..	D
21st March and 23rd September, Equinoxes..	0 ..	C
18th February and 25th October	11¾°S. ..	B
22nd December, Solstice	23½°S. ..	A

A house is shown on each of the diagrams in order to illustrate the method of ascertaining the amount of sunshine intercepted by an obstacle.

Mounting and Adjustment.

The instrument should be mounted on a level and rigid surface, preferably a brick or concrete pier. Modern forms have a stout square base of heavy metal with a lug on each side by means of which it can be secured to its support.

The proper adjustment of the sunshine recorder is rather troublesome, but it is important that it should be done accurately. The following are the adjustments which it is necessary to make :—

(1) The centre of the glass sphere must coincide with the centre of the bowl.

(2) The plane cutting an equinoctial (straight) card, mounted under the central flanges on the bowl, along its central line must be inclined to the vertical at an angle equal to the latitude of the place. In the type figured this would mean that the axes of the screws $\mathbf{P}_1,\mathbf{P}_2$, which clamp the glass sphere in position, must be parallel to the axis of the earth; $\mathbf{P}_1,\mathbf{P}_2$ is then the polar axis of the sphere.

(3) The instrument must be level as regards east and west, i.e., the plane bisecting the bowl must be vertical. The noon lines of all cards and the centre of the sphere should, of course, lie in this plane.

(4) The last-mentioned plane must also be in the meridian.

The screws $\mathbf{P}_1$ and $\mathbf{P}_2$ bear on to pivot holes in the glass sphere, the end of the upper one being truncated, while the lower has a conical point. The construction should be such that the axes of these screws lie in a straight line, which also passes through the centres of the bowl and the glass sphere. The bowl is screwed to the metal arc which supports the screws $\mathbf{P}_1,\mathbf{P}_2$, and should be symmetrical about it. Thus, when the base is level, the arc should be in vertical plane and the bowl level in the direction at right angles to this plane. For these adjustments the maker is responsible, and in case of any serious defect in these directions the instrument should be returned.

Adjustment for Concentricity.

Lack of concentricity due to the centre of the glass sphere being displaced towards one or other of the ends of the polar axis can be corrected by adjusting the position of the screws $\mathbf{P}_1,\mathbf{P}_2$. When the correct position is found, the screws should be firmly clamped by means of the lock nuts provided. This adjustment should have been made by the maker before sending the instrument out, and the screws should not be moved unless it has been definitely ascertained that the setting is in error. This is the only adjustment for concentricity that can be made by the observer. A rough test of the setting can be made by passing a sovereign or other disc of the correct diameter between the glass sphere and the bowl at various places.

Adjustment for Meridian.

Having laid out a meridian line passing through the recorder in the manner described on pages 17 and 18, the instrument can be set fairly accurately in the meridian by sighting along the edges of the support holding the metal arc, or by means of sighting points fixed to the ends of the polar axis. When all other adjustments have been made, the instrument will be in the meridian if it indicates *local apparent time* correctly. It is well to test it near noon.

Adjustment for Level.

The base of the instrument should first of all be levelled by means of a spirit level. The arc should then be turned until the rims of the bowl are as nearly as may be horizontal. The levelling in the east and west direction can then be tested by resting a striding level from one side to the other of the rim. A spirit level should always be reversed when a test is being made, in case there is some error in the adjustment of the level itself.

Adjustment for Latitude.

The instrument is set to the correct latitude by moving the arc carrying the bowl until the index engraved thereon comes opposite the point on the graduated arc on the support corresponding with the latitude of the place. When the setting has been made, the arc should be clamped firmly in position by means of the bolt and nut provided. If the latitude adjustment is correct, the sun will describe a line parallel to the centre line on the card. At the equinox this line will coincide with the centre line of the card.

If all adjustments are satisfactory, the trace should be narrow and be parallel to the centre line on the card. A few seconds' bright sunshine should suffice to score the card. If the trace is wide and ill-defined, the focussing is bad, and there is probably error of concentricity. If the latitude setting is wrong, the trace will be curved upwards or downwards relative to the centre line. A trace which is straight but not parallel, at the equinox, to the centre line would indicate errors of level or concentricity.

Once adjusted, the instrument should be screwed so firmly to its base that the changing of the cards should not disturb it. In some cases the base is fixed in a bed of cement.

Observers will be familiar with the method of obtaining local mean time, and be able to convert from standard time when required. The sunshine recorder, however, since its record is made by the apparent

—	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1 ..	−3½	−14	−12½	−4	+3	+2½	−3½	−6	+ ½	+10½	+16½	+10½
4 ..	−5	−14	−12	−3	+3½	+2	−4	−6	+1½	+11½	+16½	+9½
7 ..	−6½	−14½	−11	−2	+3½	+1½	−4½	−5½	+2½	+12½	+16	+8
10 ..	−7½	−14½	−10½	−1	+4	+1	−5	−5	+3½	+13	+16	+7
13 ..	−9	−14½	−9½	− ½	+4	0	−5½	−4½	+4½	+14	+15½	+5½
16 ..	−10	−14½	−8½	+ ½	+4	− ½	−6	−4	+5½	+14½	+15	+4
19 ..	−11	−14	−8	+1	+3½	−1	−6	−3½	+6½	+15	+14½	+2½
22 ..	−11½	−14	−7	+1½	+3½	−2	−6	−2½	+7½	+15½	+13½	+1
25 ..	−12½	−13½	−6	+2	+3½	−2½	−6	−2	+8½	+16	+12½	− ½
28 ..	−13	−13	−5	+2½	+3	−3	−6	−1	+9½	+16	+11½	−2
31 ..	−13½	..	−4	+3	+2½	−3½	−6	0	+10½	+16½	+10½	−3½

sun, should show local apparent time. To obtain local apparent time from local mean time, a correction called the *equation of time* must be applied. The above table gives the correction to be applied for every third day in leap year to the nearest half-minute. The equation of time differs slightly from year to year at the same date, but the table will be a sufficiently close approximation for any year. A + sign indicates that the correction must be added, and a − sign that it must be subtracted from local mean time. Thus, for a place in Victoria in longitude 142° 10′, local mean time is 31⅓ minutes slow on standard time. On 6th January, the equation of time is − 6 minutes, therefore 9 a.m. standard time on 6th January is 9 hours − 31⅓ minutes −6 minutes =8 hours 22⅔ minutes local apparent time.

Care and Use of the Instrument.

The glass sphere and the grooves in which the cards slide should be cleaned periodically.

A fresh card should be inserted every day, even if the card removed is blank. The latter should be dated and filed in the usual manner. Were this not done, doubt might arise at some later date as to whether there was no sunshine or the record had been mislaid. The card should be changed at the same hour every day. If it is possible, it is an advantage that this hour should be after sunset, as the record would then refer to one day only, and there would be no danger of one day's record overlapping another's. If the sun is shining at the time when a fresh card is being inserted, the observer should shade the ball until the card is in position, in order to prevent a false record being made. This card should be set so that the 12-hour line coincides with the noon line in the bowl. The card should be stored flat, and never folded.

The Cards.

Three types of card are supplied for use with each instrument—

(1) The *long curved cards* are to be used during *summer*, from 13th October to the last day of February.

(2) The *short curved cards* are to be used during *winter*, from 13th April to 31st August inclusive.

(3) The *straight cards* are used about the *equinoxes*, from 1st March to 12th April, and again from 1st September to 12th October, inclusive in both cases.

Into which set of flanges to insert the card will be obvious to the observer. When a straight card is inserted, the hour figures should be erect.

The length of card required will vary with the latitude, and account must be taken of this when ordering supplies. Many almanacs, books of tables, &c., give the times of sunrise and sunset for different latitudes

at different times of year. The longest possible record on the summer card will occur at the solstice on 22nd December, on the winter card on 13th April or 31st August, and on the equinoctial card on 1st March or 12th October. The time between sunrise and sunset on these days can be found, from tables given in a number of publications, for the latitude of the station, and the right length of card deduced. The same information can be derived approximately from the diagrams of Figure 18. The depth to which the flanges are cut varies slightly in different instruments, and the width of the slots should, therefore, be furnished when sending any order. The hemisphere in which the cards are used should be stated, as the numbering of the hours is in the reverse direction in the two hemispheres.

Measurement of the Records.

The sunshine recorder does not record all the hours during which the sun is visible to the naked eye, but only those during which it is bright enough to burn the card. In order that records should be comparable, therefore, it is necessary that the sphere should be of the standard size and the standard make of glass. Crown glass is now used, and it should be colourless or a pale-yellow. The trace should be measured in hours and tenths. Faint traces should be included in the measurements as long as any scorching is definitely visible. When a trace ends or begins in bright sunshine, the record will extend beyond the centre of the sun's image, and some allowance must be made. For instance, a few seconds of bright sunshine will produce almost as long a record as two or three minutes. A good approximation is to measure to the centre of a semicircular end of the trace. The observer should check his measurements occasionally by comparing them with the actual duration of sunshine during bright intervals on days of passing cloud.

The time scale of the record is different on the curved cards from that of the equinoxial card, and changes with the sun's declination, and although the hours are supposed to be correctly ruled on the cards, it is desirable to use separate scales for measurement. The scales corresponding with different dates are given in the *Observer's Handbook*, M.O. 191 of the London Meteorological Office publications. Specifications for the dimensions, &c., of the standard recorder, the fulfilment of which is of great importance, will be found also in the same volume.

PART III.

Supplementary Instructions, Specifications, Etc.

Evaporimeters.

Vessels or tanks used for determining the amount of evaporation should be exposed in as natural a way as possible. The conditions for a suitable site for a rain-gauge hold, in general, for the case of an evaporimeter also. The vessels should be fenced round to prevent dogs or other animals drinking from them.

The evaporimeter at present used in Australia generally consists of two cylindrical tanks let, one inside the other, into the ground. The inner tank is 2 inches deeper than the other. The outer tank is sunk flush with the ground, and must rest on a smooth, well-packed, level bottom. Projecting stones are liable gradually to produce leaks. Both tanks should be tested for leaks before being put in position, especially the inner one. The inner tank rests on the floor of the outer, and is concentric with it. Both cylinders should be filled with water at the same time, the outer being completely filled, and the inner to within 3 inches of the top. They should subsequently be kept approximately in these positions The outer tank A (see Fig. 19) acts as a guard ring to the inner one, producing approximately uniform conditions over its surface. It also prevents birds and small animals from crawling into or drinking from the inner one. To the inner tank B is fixed an upright standard CD, carrying at its upper end the measuring apparatus. This standard is stayed by straps to the rim of the outer tank. The amount of evaporation is measured by the change in the level of the water surface in the inner vessel. This is indicated by the height of the pointed end of a rod FP attached to a glass float F. The rod passes through holes in brackets G, H, L, carried by the standard CD. Between the bracket L and the top bracket K of the standard is bolted the micrometer, which is a phosphor bronze rod on which an accurate screw thread is turned. On this rod works a circular disc N on the upper surface of which is engraved a scale dividing the circumference into 100 equal parts. On the under surface of the disc is a collar carrying the index arm XY, which can rotate freely round the collar. One end of the index arm carries the pointer I, which projects over the edge of the disc on to the scale. Alongside the pointer in the index arm is a slot into which fits the vertical scale ST. The vertical

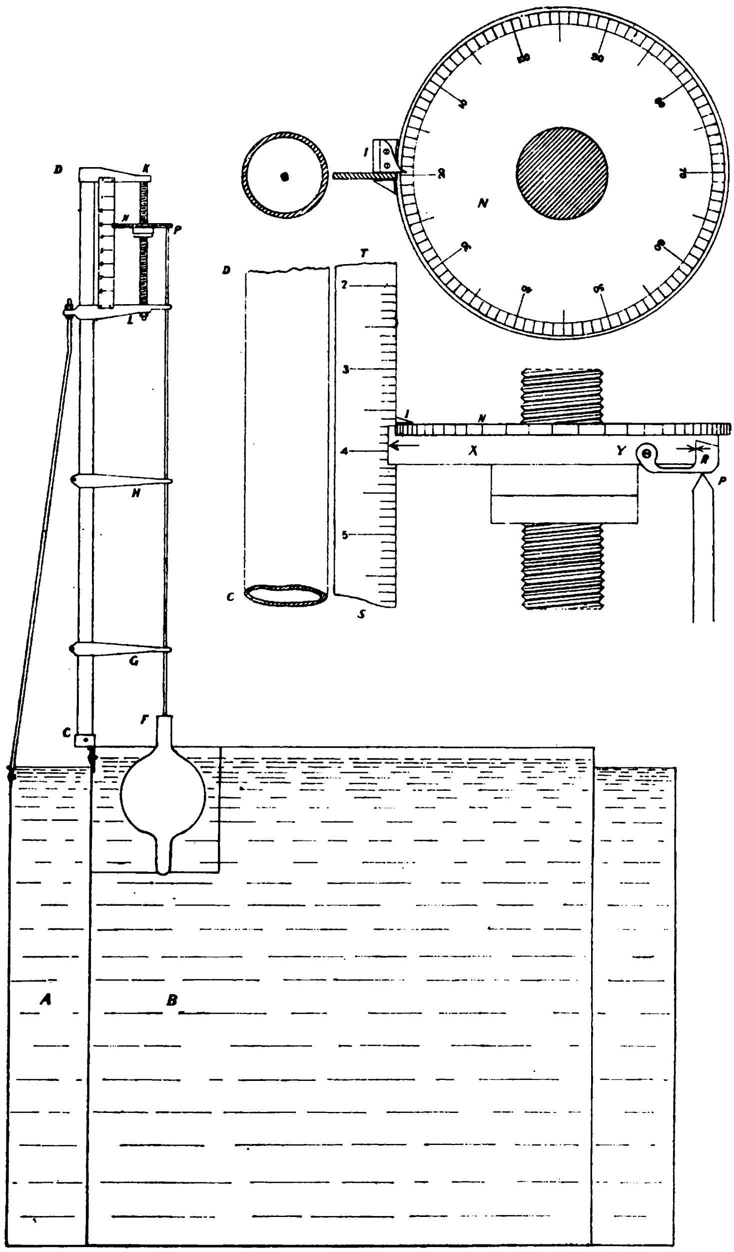


FIG. 19.—EVAPORIMETER.

scale is graduated in inches and tenths, and as there are ten threads to the inch on the rod LK the scale divisions on the disc are thousandths of an inch. The position of the disc relative to the vertical scale can, therefore, be read to the nearest thousandth of an inch.

The float F should be three quarters covered with water, and can be adjusted to this position by placing shot in the bottom to the right amount. When the adjustment has been made the cork should be fixed securely in the neck of the float and then sealed with red lead.

To make a reading, the float should first be totally immersed so as to wet the surface. Spin the float so as to make sure that the rod is moving freely in the guide holes. Then screw the disc N down until the point P of the float rod comes into contact with the adjustable leaf R on the under side of the index arm. Continue to screw down gently until the arrow mark on R coincides with that on the index arm. The instrument is now ready for reading. The vertical scale ST is first read, the division next above the arrow mark on the index arm being recorded, e.g., in the figure 3.9 inches ; the hundredths and thousandths are then read off the graduated plate. In the figure the scale reading is 20 ; therefore the complete reading is 3.920 inches. After reading, the index is screwed up to some inches above the rod, so that in case of rain the latter shall not come in contact with it. In the case of very heavy rain, when there is danger of the inner tank overflowing, some water should be baled out, readings being taken before and after in order that the amount may be determined. In any case in which it is necessary to add or remove water, such readings should be taken and recorded in the register with an explanatory note.

The amount of evaporation is arrived at thus* :—If the reading entered in the Field Book yesterday morning was 2.449, enter that number in the space marked "Left yesterday" ; enter to-day's reading (2.652) in the space below, and the difference between the two (0.203 inch) is the amount of evaporation for the 24 hours ending at 9 a.m. to-day. When rain has fallen (e.g., 16 points) add this amount to to-day's reading before subtracting yesterday's, as shown hereunder :—

To-day	2.652	inches.
Rainfall	0.16	,,
Sum ..	2.812	inches.
Yesterday	2.449	,,
Amount of evaporation..	0.363	,,

*N.B.—One or two of the evaporimeters at present in use have scales whose readings increase upwards. In this case, the rainfall is to be subtracted from to-day's reading, and the remainder subtracted from yesterday's reading, thus:—

Left yesterday		2.302 inches.
Reads to-day	2.314 inches.	
Rainfall	0.16 "	
		2.154 "
Amount of evaporation		0.148 "

All parts of the apparatus should be kept clean, including the surface of the water. The float rod should be kept greased, and the micrometer gear slightly oiled.

Note.—Some of the older pattern evaporimeters are without the adjustable leaf R. With these the graduated circle is screwed gently down until it just touches the float rod when a reading is to be made.

Ferro-Concrete Evaporation Tank.

In some districts galvanized iron tanks corrode rapidly underground or when filled from the local water supply. This difficulty has been met by the construction of evaporimeters of ferro-concrete. The use of ferro-concrete makes the provision of a guard ring impracticable. It is necessary, therefore, to exercise additional care in protecting the water from the depredations of birds and animals. The concrete wall is a good insulator, and maintains steady conditions.

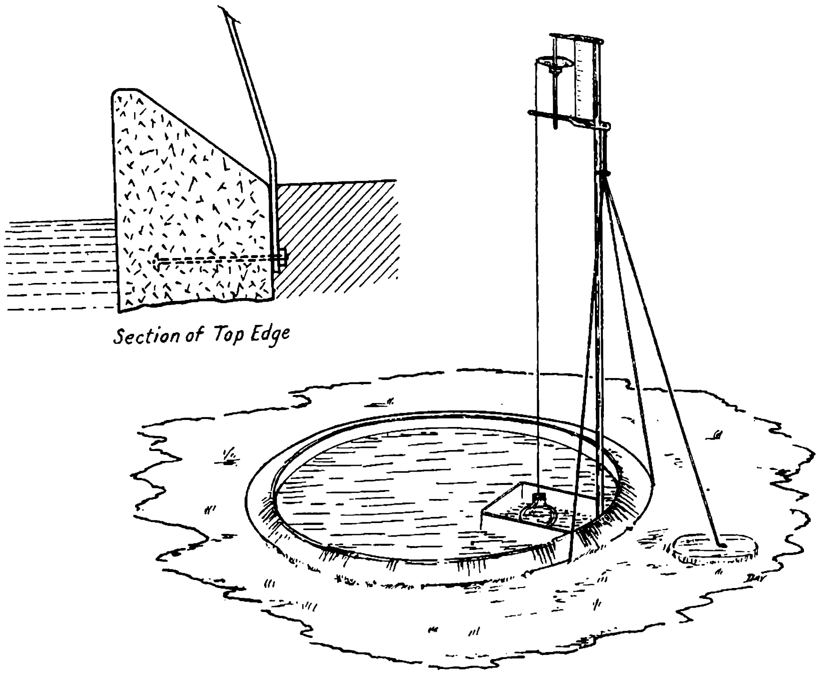


FIG. 20.

The tank is illustrated in Fig. 20, and the details of the construction are as follows:—

Walls and bottom to be 3 inches in thickness of waterproofed concrete reinforced with $\frac{3}{8}$-in. iron rods bound together with wire.

The wall is to be flush with the ground on the outside, and with its upper surface bevelled so that the inner edge is 2 inches above the ground level.

For waterproofing of the concrete, the best local advice (e.g., from Public Works or Railway Departments) is to be sought.

The standard of the measuring apparatus is let into the top of the wall and secured by bolts built into the concrete and fixed in a template.

Bolts are also set in the concrete for attaching the stays and the galvanized iron dock for the float, those for the latter being of brass.

The standard is kept rigid by means of three stays, two being attached to bolts on the outside of the concrete wall, and the third to one set in a block of cement laid in the ground at a little distance from the tank (see figure).

Determination of Cloud Movement by means of a Nephoscope.

If accurately made, observations of the direction and speed of movement of cloud are very valuable, both for forecasting and for general theoretical purposes. To secure accurate observations, some form of nephoscope should be used, the direct vision type being probably the most convenient.

Besson's Comb Nephoscope.

Besson's comb nephoscope (Fig. 21) will serve as an example of a direct vision nephoscope. It consists of a brass rod about 9 feet long, bearing at its upper end a cross piece $3\frac{1}{3}$ feet long, to which a number of equidistant vertical spikes are attached. The spikes should divide the cross piece into five lengths, which each subtend 3° at the eye of the observer, the middle division being bisected by an additional central spike. The rod is mounted in a vertical position by means of a number of rings and clamps screwed into a tall post in such a manner that it can rotate freely. Its height should be adjusted so that a fixed mark on the rod is at the level of the observer's eye.

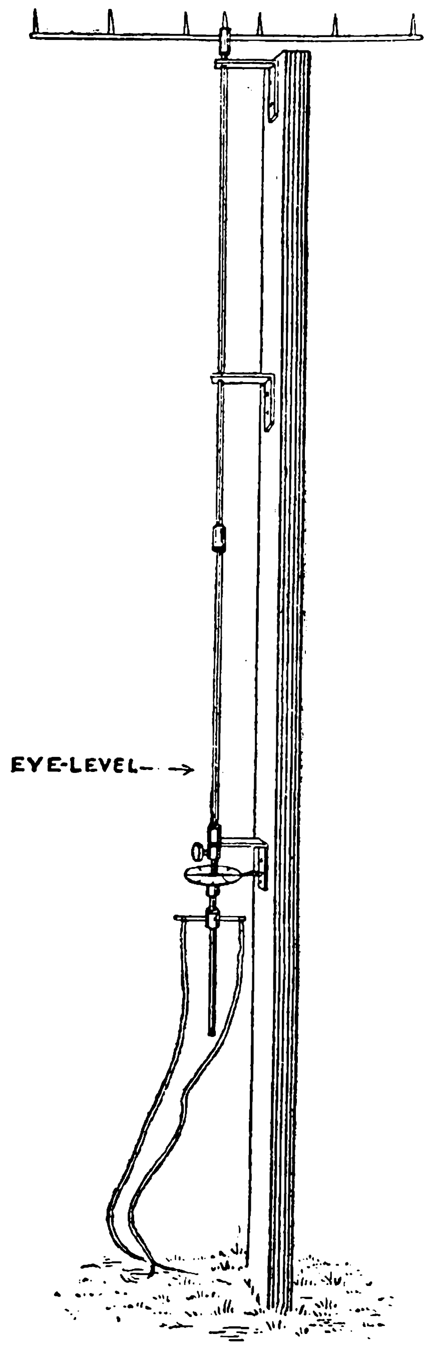


FIG. 21.

When using the apparatus the observer stations himself in such a position that the cloud selected for observation is seen in the same straight line as the central spike. He then turns the cross piece until the cloud appears to travel along the line of spikes while he himself remains motionless. The cross piece will then be parallel to the line of motion of the cloud, and the direction in which it points can be read off on

a graduated circle which is provided for the purpose. The rod may be turned by the observer standing at some distance away from it by means of two cords tied to a second shorter cross piece attached to its lower extremity or working in a groove on the rim of the graduated circle. For strict accuracy it should be possible to adjust the height of the vertical rod so as to bring the same point to the level of the eye for each observer.

The velocity-height ratio may be determined by noting the time taken for the cloud to pass from spike to spike. If a be the distance between the spikes, and b the distance from the upper cross piece to the marked point on the rod which has been adjusted to the level of the observer's eye, and t the observed time in seconds, we have velocity-height ratio $= \frac{a}{bt}$.

Both a and b must be measured in the same units. The difference in level between the cross piece and the observer's eye should be the same in all experiments, and hence the instrument must be set up on a level site. If slow-moving clouds are being watched, the observer will require a fixed support to steady his head if satisfactory results are to be obtained. He will also need smoked glass spectacles to protect his eyes.

Method of Stating Results of Nephoscope Observations.

The velocity-height ratio has the dimensions of an angular velocity, for which the usual unit is one radian per second. As this unit is too large for the purpose, it is better to take the milliradian per second (mr/s). The formula used is—

$$V = 1000 \frac{a}{bt}$$

where V is the velocity-height ratio in milliradians per second.

To determine the actual velocity, the height of the cloud must be known as well as the velocity-height ratio.

At stations where pilot balloon ascents are made, the pilot balloon theodolite forms an excellent nephoscope. A cloud point is set on and followed in the same way as is a balloon, and its azimuth and altitude observed at the beginning and end of a convenient interval. A practical observer can usually make a good estimate of the height of the cloud, and using this estimated height, the direction and velocity of the cloud movement can be worked out quickly by the same method as for the balloon. In this manner it is frequently possible to get a very good idea of the general movement of the atmosphere when clouds at different levels are visible. The method is a very flexible one. When the cloud point is not very distinct, the vision is considerably aided if the field is kept moving by turning the altitude screw backwards and forwards. Another method is to use the pointing device attached to the telescope.

Visibility at Land Stations.

The development of aviation has attached great practical importance to the condition of the atmosphere as regards the visibility of distant objects. It is by sighting objects on the ground that a pilot directs his course and adjusts his flying height. In general, in Australia, bad visibility is so rare that it is not one of the serious obstacles to the maintenance of regular air services. In some important regions, however, the reverse is the case, and at all stations there will be occasions on which flying will be rendered dangerous by low visibility. Again, a detailed study may show that visibility observations are of value for forecasting purposes.

In measuring visibility it is important that a uniform system be adopted. Such a system was developed by international agreement in Europe, and has now been adopted in Australia.

The method is to select or set up suitable objects at standard distances from the point of observation. The distance of the furthest of these objects which is visible, or the nearest which is invisible, is then the measure of the visibility at the time of observation. The code is given in the following table :—

Code Letter.	Code Number.	Definition.
A	0	~~Objects not visible~~ at ~~25 metres~~ (~~27 yards~~)
B		Objects visible at 25 metres, but not at 50 metres (55 yards)
C	1	,, ,, 50 ,, ,, ~~100~~ ,, (110 yards)
D		,, ,, ~~100~~ ,, ,, 200 ,, (220 yards)
E	2	,, ,, 200 ,, ,, 500 ,, (550 yards)
F	3	,, ,, 500 ,, ,, 1,000 ,, (1,100 yards)
G	4	,, ,, 1,000 ,, ,, 2,000 ,, (1¼ miles)
H	5	,, ,, 2,000 ,, ,, 4,000 ,, (2½ miles)
• I	6	,, ,, 4,000 ,, ,, [illegible]000 ,, (4 miles)
• J	7	,, ,, [illegible],000 ,, ,, [illegible]000 ~~(7½ miles)~~
• K	8	[illegible] ,, ,, [illegible] ,, (12½ miles)
L		,, ,, 20,000 ,, ,, 50,000 ,, (30 miles)
M	9	,, ,, 50,000 metres or more

The letter code should be used for insertion in the monthly return, and the figure code in telegraphed messages, should they be called for. The nature of the objects set up or selected at the standard distances is important. The *Observer's Handbook*, issued by the London Meteorological Office, states that the ideal object should subtend at the observer's eye 10 minutes of arc in length and 2½ minutes in breadth. At a mile, this would give a measure of 15 feet x 4 feet. Such objects as church spires or factory chimneys would be satisfactory. It is very desirable that the objects should be on the sky line, and well illuminated. If objects at the precise distances mentioned above are not available, an attempt should be made to secure them at as nearly these distances as possible. Where no very distant objects are available, an estimate should

be made, in clear weather, from the relative clearness with which the most distant object is visible, of the higher degrees of visibility. In all cases the Central Bureau should be furnished with a description of the objects used and the general conditions, so that the weight to be attached to an observation may be known.

In addition to a regular record of the visibility at the times of observation, information under the following heads would be valuable, and should be supplied as far as possible :—

(*a*) Notes as to special conditions of visibility at times other than the regular observing hours.

(*b*) The times of occurrence and the duration of bad conditions, especially fog.

(*c*) Whether the visibility is different in different directions, e.g., towards the sea and towards the land ; towards or away from a city.

(*d*) Whether, when bad visibility occurs at a station, especially through fog, other places near by are free from this disability.

(*e*) The presence of low cloud. In some cases the height of the cloud can be determined from the height at which it touches a hill slope.

(*f*) Bad visibility is sometimes caused by dust storms, smoke, or a dark lowering sky, and information regarding such occurrences would be valuable.

Visibility observations need be undertaken at those stations only whence they are specifically requested. So far, no scheme for measureing visibility in the vertical direction has been devised. For the present, also, observations are confined to the daylight hours.

Visibility at Sea.

Observations of the horizontal visibility at sea furnish useful information to ships approaching the areas in which the observations are made. They also give valuable information concerning the weather.

The system of measuring the visibility at sea is similar to that adopted on land, and the standard distances used are similar. The code adopted by international agreement is as follows :—

Code Figure.	Description.
0	Dense fog, objects not visible at 50 yards
1	Thick fog, objects not visible at 1 cable
2	Fog, objects not visible at 2 cables
3	Moderate fog, objects not visible at ½ mile (nautical)
4	Thin fog or mist, objects not visible at 1 mile (nautical)
5	Visibility poor, objects not visible at 2 miles (nautical)
6	Visibility moderate, objects not visible at 5 miles (nautical)
7	Visibility good, objects not visible 10 miles (nautical)
8	Visibility very good, objects not visible at 30 miles (nautical)
9	Visibility exceptional, objects visible more than 30 miles (nautical).

If the visibility is exceptionally good, the letter v should be entered in the weather column of the meteorological log.

Objects for judging the visibility are not, of course, plentiful at sea, but neighbouring coast-lines, passing ships, the distance of the visible horizon, &c., can be made use of.

Sea-Disturbance.

The state of the sea is recorded by the following arbitrary scale, which is taken from the *Observer's Handbook* (M.O. 191, London) :—

Scale Number.	Description.	Condition of Surface.	Scale of Heights.
			Feet.
0	Calm	Glassy	0
1	Very smooth ..	Slightly rippled	..
2	Smooth	Rippled	..
3	Slight	Rocks buoy, or small boat ..	Under 5
4	Moderate ..	Furrowed	Under 5
5	Rather rough ..	Much disturbed	5 to 10
6	Rough	Deeply furrowed	5 to 10
7	High	Rollers, with steep fronts	11 to 15
8	Very high ..	Rollers, with steep fronts	16 to 35
9	Phenomenal ..	Precipitous ; towering..	Above 36

Visibility at Sea.

Observations of the horizontal visibility at sea furnish useful information to ships approaching the areas in which the observations are made. They also give valuable information concerning the weather.

The system of measuring the visibility at sea is similar to that adopted on land, and the standard distances used are similar. The code adopted by international agreement is as follows :—

Code Figure.	Description.
0	Dense fog, objects not visible at 50 yards
1	Thick fog, objects not visible at 1 cable
2	Fog, objects not visible at 2 cables
3	Moderate fog, objects not visible at ½ mile (nautical)
4	Thin fog or mist, objects not visible at 1 mile (nautical)
5	Visibility poor, objects not visible at 2 miles (nautical)
6	Visibility moderate, objects not visible at 5 miles (nautical)
7	Visibility good, objects not visible 10 miles (nautical)
8	Visibility very good, objects not visible at 30 miles (nautical)
9	Visibility exceptional, objects visible more than 30 miles (nautical).

If the visibility is exceptionally good, the letter v should be entered in the weather column of the meteorological log.

Objects for judging the visibility are not, of course, plentiful at sea, but neighbouring coast-lines, passing ships, the distance of the visible horizon, &c., can be made use of.

Sea-Disturbance.

The state of the sea is recorded by the following arbitrary scale, which is taken from the *Observer's Handbook* (M.O. 191, London) :—

Scale Number.	Description.	Condition of Surface.	Scale of Heights.
			Feet.
0	Calm	Glassy	0
1	Very smooth ..	Slightly rippled	..
2	Smooth	Rippled	..
3	Slight	Rocks buoy, or small boat ..	Under 5
4	Moderate ..	Furrowed	Under 5
5	Rather rough ..	Much disturbed	5 to 10
6	Rough	Deeply furrowed	5 to 10
7	High	Rollers, with steep fronts	11 to 15
8	Very high ..	Rollers, with steep fronts	16 to 35
9	Phenomenal ..	Precipitous ; towering..	Above 36

Barometers Reading in Millibars.

The instructions already given for the reading of the attached thermometer and setting of the vernier of the barometer graduated in inches will apply also to those graduated in millibars. The attached thermometer is graduated in degrees on the absolute scale, and should be read to the nearest tenth of a degree. The millibar graduations on vernier and scale are illustrated in Figs. 22 and 23. The scale is graduated in millibars, and the centibar divisions (10 millibars = 1 centibar) are numbered along it. In order to facilitate reading, the millibar divisions are of graduated lengths, as shown in the figures. In Fig. 22, D, the zero division on the vernier, is supposed to be in the same straight line with the fifth (the long) division above the scale division numbered 98, in other words, with the 985 millibar graduation. In Fig. 23, the graduation next below D is the second above the graduation numbered 101, its value is, therefore, 1,012 millibars. Looking now along the vernier, we see that the seventh division is in the same straight line with

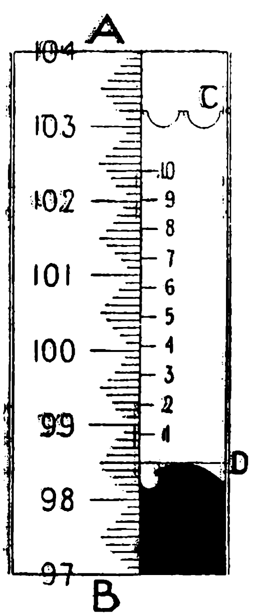


FIG. 22.

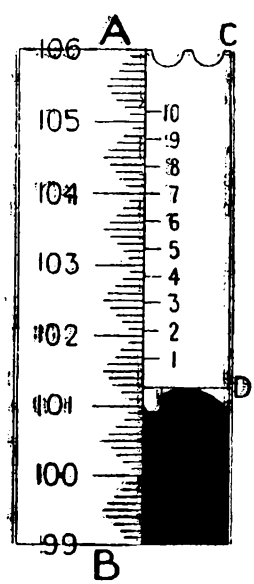


FIG. 23.

a scale division. The value of this division on the vernier gives the decimal place. The complete reading, therefore, is 1,012.7 millibars. In the other figure the zero division of the vernier is exactly opposite the 985 mb. division, and the reading is 985.0. Similarly for other positions of the vernier.

The Reduction of Readings of Barometers Graduated in Millibars.

The following is taken, with only slight modification, from the London Meteorological Office *Observer's Handbook* :—

Barometers supplied by English makers are sent before issue to the National Physical Laboratory for comparison with the standard instrument of that institution. As the reading of a barometer is not independent either of the temperature of the instrument or of the latitude of the place where it is set up, it follows that the 100 centibar, or 1,000 millibar graduation can only be correct at one particular temperature for each latitude. The temperature appropriate for latitude 45° is called the "standard temperature" of the barometer, and, according to present practice, is engraved upon it. The temperature appropriate for each latitude can be determined from the standard temperature by means of Table XI.C.

This temperature, at which the barometer reads correctly in any locality, is called the *fiducial temperature* for the locality. If the temperature of the instrument, as shown by the attached thermometer, does not happen to be the fiducial temperature, a suitable correction must be applied, as set out in Table XI.A for Fortin and XI.B. for Kew pattern barometers.

Further, the conditions as to temperature and latitude which insure that readings at 1,000 mb. are correct are not necessarily suitable for other parts of the scale. The standard temperatures corresponding with the standard latitude of 45° for several readings of the barometer are given in the certificate of the National Physical Laboratory.

Lastly, barometer readings require to be reduced to mean sea level before they can be compared with one another. The magnitude of the correction depends on the temperature of the outside air (dry bulb in screen) as well as on the height of the station above sea level. For heights less than 15 metres correction may be made by adjusting the fiducial temperature. The corrections for reducing to sea level are given in Table XI.D.

Reduction by Means of Fiducial Temperature.

(a) *To find the Fiducial Temperature from the Standard Temperature.*

The certificate of the National Physical Laboratory for the millibar scale of a barometer gives the standard temperatures for different parts of the scale. Thus, the following is the list of standard temperatures for barometer B.T. 350 (Kew pattern) :—

Pressure	920	940	960	980	1,000	1,020	1,040 mb.
Standard Temperature ..	286.4	286.2	286.1	286.0	285.9	285.8	285.7 a.

It will be remembered that the standard temperature is the temperature at which the barometer reads correctly in latitude 45°. At a more northerly station, say, for example, in latitude 33½°, the gravitational attraction is weaker. If the same reading of the barometer is to indicate the same pressure, the mercury must be heavier, and, therefore, colder. The necessary decrease in temperature (given by Table XI.C) is – 6.0 a.

Accordingly for the barometer in question, we have the following table :—

Barometer B.T. 350 in latitude 33½°.

Pressure	920	940	960	980	1,000	1,020	1,040 mb.
Fiducial Temperature ..	280.4	280.2	280.1	280.0	279.9	279.8	279.7 a.

(b) *To find the Pressure at Station Level.*

The correction to be applied to the barometer reading when the temperature of the attached thermometer differs from the fiducial temperature is given for a Fortin barometer by the formula—

$$p - p_1 = a\, p_1\, (t_0 - t_1)$$

and for a Kew pattern barometer by the modified formula—

$$p - p_1 = (a\, p_1 + \beta)\, (t_0 - t_1).$$

In either formula p is the required pressure in millibars; p_1 is the reading of the barometer; t_0 is the fiducial temperature in degrees absolute; t_1 is the reading of the attached thermometer, corrected if necessary; and a is a constant which is equal to .000163 for any barometer with a brass frame.

Until recent years the fact that observations made with a Kew pattern barometer should be reduced by a special formula had been overlooked. The term β which occurs in the formula depends on the dimensions of the barometer; it is determined by the equation $\beta = .00023\ M/a^2$, where M is the mass in grams of the mercury in the barometer, and a is the diameter of the cistern in centimetres. For barometers of the usual dimensions β may be taken as .008.

Temperature corrections for Kew pattern barometers are given in Table XI.C. To facilitate interpolation, the corrections are given in the tables to two decimal places.

As an example, suppose the reading of barometer B.T. 350 in latitude 33½° is 975.2 mb. and the reading of the attached thermometer is 295.2 a. In this case the fiducial temperature is 280.0 a, and, therefore $t_0 - t_1 = -$ 15.2 a. Table XI.C gives the corrections as 2.54, or 2.5 to one decimal place. As the fiducial temperature is below the actual temperature, the correction is to be subtracted, and the required pressure is, therefore, 972.7 mb.

(c) *To Reduce the Readings to Sea Level.*

As described above, the pressure at sea level is obtained by adding to the pressure at station level the weight of a column of air at the appropr'ate temperature and pressure.

Tables XI.D and XI.E give the corrections for selected heights and temperatures when the pressure at station level is 1,000 mb. For other pressures the correction is in proportion. To avoid the accumulation of errors, the corrections in Table XI.D, referring to moderate heights, are given to two decimal places. When greater heights are in question the uncertainty as to the temperature to be assumed for the air column makes it useless to aim at the highest precision in the reduction of pressure, and the corrections in Table XI.E are only taken to one place of decimals.

To reduce to sea level a pressure of 974.3 mb., observed at 38 metres when the air temperature is 68° F., the correction for 1,000 mb. is taken from Table XI.D. By interpolation between 4.49 and 4.33 corresponding to 63° F. and 81° F., the correction at 68° F. is found to be 4.45 mb. The correction for 974.3 mb. is less by 2.6 per cent.; it is therefore 4.45 — .11,or 4.3 mb. Thus the sea level pressure is 974.3 + 4.3, or 978.6 mb.

As an example of the complete process of reduction, sea level pressure is found from the following data :—Barometer reading, 1,017.6 mb. ; attached thermometer, 294.5a ; air temperature, 273a ; height of barometer cistern, 13 m. ; latitude, 60° S. ; standard temperature of barometer at 1,020 mb., 284.3a.

	a.		mb.
Standard temperature	284.3	Barometer reading ..	1,017.6
Latitude correction ..	+7.9	Temperature correction	—.4
Fiducial temperature ..	292.2	Station pressure ..	1,017.2
Actual temperature ..	294.5	Height corr. (1000 mb.)	1.63
		Height corr. (17 mb.) ..	.03
Difference ..	—2.3	Sea level pressure ..	1,018.9

(d) *Simplification for Stations at Low Levels.*

For stations at low levels (within 15 metres of sea level), the correction for height does not depend appreciably on the temperature of the air, and it is found convenient to use the " Fiducial Temperature for Sea Level Readings." This is the temperature of the barometer for which the readings of the scale give pressure at sea level without any correction. This temperature is higher than the " Fiducial Temperature for Station Level Readings," and the difference, in degrees a, is seven-tenths of the height of the station in metres. In the last example the " Fiducial

Temperature for Sea Level Readings" would have been 301.3a. The actual temperature was low by 6.8a, and, by Table XI.C, the corrections to the barometer reading would be found to be 1.2 mb. Thus the error due to the adoption of the simplified method would be only .1 mb.

Reduction by Adjustment of the Temperature of the Attached Thermometer.

The theory of this method is given in the paper by E. Gold, *Quarterly Journal of the Royal Meteorological Society*, xl., p. 185, 1914.

The method is indicated on the specimen copy of the form used for the correction to be applied to barometer readings at London Meteorological Office Stations which follows, and is continued on the next page. The table in the second paragraph gives the corrections when the air temperature is 16° F. In these circumstances, the fiducial temperature for sea level pressure of the particular barometer is 293a. When the air temperature is 48° F., the fiducial temperature is 292a. With such an air temperature, the reading of the attached thermometer is "adjusted" by adding 1a, so that if the thermometer reading is 292a, the "adjusted" reading is 293a, and the table indicates that no correction to the barometer reading is necessary.

FORM 201.

Barometric Correction and Reduction to Mean Sea-level.

Place—South Kensington. Latitude—51° 30′ N.
Height above M.S.L.—21.3 metres. Barometer—No. 1332.

(1) Adjust the reading of the attached thermometer by adding the amounts given below :—

Dry bulb in screen.	Correction to attached Thermometer.	Dry bulb in screen.	Correction to attached Thermometer.
Below 32° F.	0a	62°-98° F.	+2a
32°-61°	+1		

FORM 201—*continued.*

(2) Apply to the observed reading of the barometer the correction of the following table corresponding most nearly with the barometer reading and the adjusted reading of the attached thermometer :—

Adjusted Reading of attached Thermometer.	Correction to be Applied.					
a.	940 mb.	960 mb.	980 mb.	1,000 mb.	1,020 mb.	1,040 mb.
271	+3·4	+3·4	+3·5	+3·6	+3·7	+3·7
272	3·2	3·3	3·3	3·4	3·5	3·6
273	3·1	3·1	3·2	3·3	3·3	3·4
274	2·8	3·0	3·0	3·1	3·2	3·2
275	2·9	2·8	2·9	2·9	3·0	3·0
276	2·6	2·7	2·7	2·8	2·8	2·9
277	2·4	2·5	2·6	2·6	2·7	2·7
278	2·3	2·3	2·4	2·4	2·5	2·5
279	2·1	2·2	2·2	2·3	2·3	2·4
280	2·0	2·0	2·1	2·1	2·2	2·2
281	1·8	1·9	1·9	2·0	2·0	2·0
282	1·7	1·7	1·8	1·8	1·8	1·9
283	1·5	1·6	1·6	1·6	1·7	1·7
284	1·4	1·4	1·4	1·5	1·5	1·5
285	1·2	1·3	1·3	1·3	1·3	1·4
286	1·1	1·1	1·1	1·1	1·2	1·2
287	0·9	0·9	1·0	1·0	1·0	1·0
288	0·8	0·8	0·8	0·8	0·8	0·9
289	0·6	0·6	0·6	0·7	0·7	0·7
290	0·5	0·5	0·5	0·5	0·5	0·5
291	0·3	0·3	0·3	0·3	0·3	0·3
292	+0·2	+0·2	+0·2	+0·2	+0·2	+0·2
293	0·0	0·0	0·0	0·0	0·0	0·0
294	−0·2	−0·2	−0·2	−0·2	−0·2	−0·2
295	0·3	0·3	0·3	0·3	0·3	0·3
296	0·5	0·5	0·5	0·5	0·5	0·5
297	0·6	0·6	0·6	0·7	0·7	0·7
298	0·8	0·8	0·8	0·8	0·8	0·8
299	0·9	0·9	1·0	1·0	1·0	1·0
300	1·1	1·1	1·1	1·1	1·2	1·2
301	1·2	1·3	1·3	1·3	1·3	1·4
302	1·4	1·4	1·4	1·5	1·5	1·5
303	1·5	1·6	1·6	1·6	1·7	1·7
304	1·7	1·7	1·8	1·8	1·8	1·9
305	1·8	1·9	1·9	2·0	2·0	2·0
306	2·0	2·0	2·1	2·1	2·2	2·2
307	2·1	2·2	2·2	2·3	2·3	2·4
308	2·3	2·3	2·4	2·4	2·5	2·5
309	2·4	2·5	2·6	2·6	2·7	2·7
310	−2·6	−2·7	−2·7	−2·8	−2·8	−2·9

Amounts entered in HEAVY type must be added. Amounts entered in ORDINARY type must be subtracted.

Specifications—Stevenson Thermometer Screen, Large Size.

Plate E, Fig. 1. End elevation.
,, Fig. 2. Section through AB.
,, Fig. 3. Section through CD.
,, Fig. 4. Plan.
,, Fig. 5. Details of roof.
,, Fig. 6. Side-plate hinges for door.
,, Fig. 7. Thermometer stand (details).

Material.—The screen is to be constructed throughout of cedar.

All parts to be put together with tenons, mortices, and brass screws ; louvres to be fastened together and fixed by brass nails.

Dimensions.—See Figs. 2, 3, and 4.

Door.—To be hung by two brass side-plate hinges (Fig. 6). Frame 1½″ x 1″ material ; 16 louvres. Closes with outer surface flush with corner posts. Brass hasp and staple fastener and padlock.

Louvres.—Double louvres, 18 on each face, 16 in door. Outer louvres 3″ x ¼″, inner 1¼″ x ¼″. Inner louvres nailed to outer, and outer held fast in grooves ¼″ x ⅛″ cut in corner posts, at an angle of 45° and ½″ apart square to groove, Figs. 2 and 3. All outer louvres to be made flush with corner posts ; inner louvres project about ¾″ into the screen. The inner louvres are carefully mitred for the corners at the back of the screen. An additional improvement is to support the louvres by slipping them, in these corners, into loose strips suitably slotted to receive them. When in position, the strips are secured to the posts by two thin screws. At the front ends of the side louvres similar strips may be fitted and pinned to the ends of the louvres, but here the louvres are not mitred. Unless the best seasoned cedar is available for the construction, it is very desirable that these supports be added.

Bottom of Screen.—½″ boards to size, Fig. 2.

Roof.—Inner roof ¾″ board resting on upper rails, Fig. 2. Holes drilled to dimensions, Fig. 4 (1″ diam., see dotted circles).

Outer Roof.—Selected seasoned timber, 3′ x 2′ 6″ over all, grooved underneath. See details, Fig. 5. Roof carried by angle iron bolted to corner posts, Fig. 5. Bolts to be of ¼″ G.I. and to pass through ⅞″ x ⅛″ G.I. strips lying along roof at back and front. Edges of boards grooved to admit tongue of No. 18 sheet zinc, ⅝″ wide (as shown). Pitch of roof shown, Fig. 2. In putting the roof together thick white paint or soft white lead putty should be freely used in the joints. Roof to be watertight. Thermometer stand, Fig. 7, fitted in screen so that the dry and wet bulb thermometers are on the left side as shown. Details of hooks for suspension of these thermometers at side of Fig. 7.

Previous to being put together, all parts to be painted, with three coats of white lead paint, and when put together to be given finishing coat of white zinc paint and varnished.

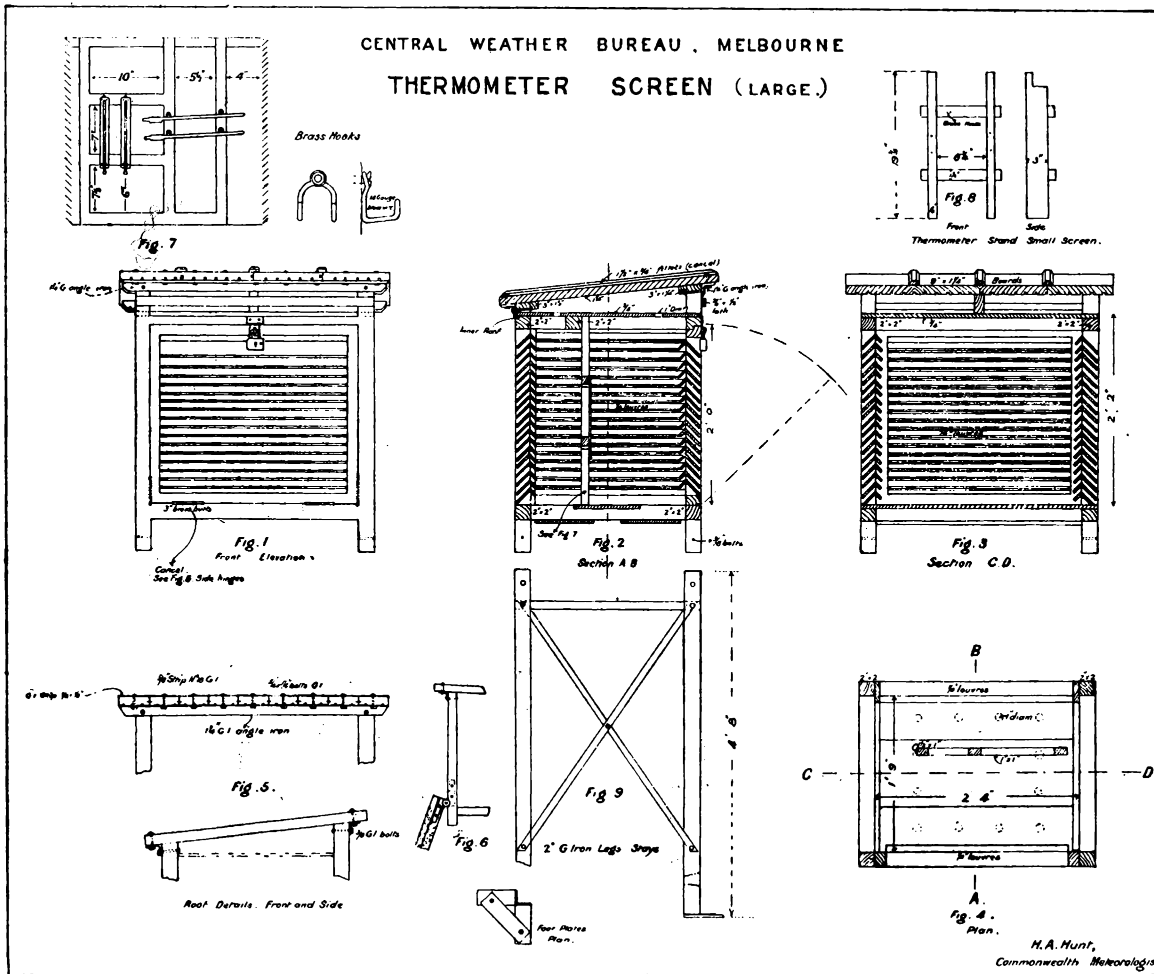
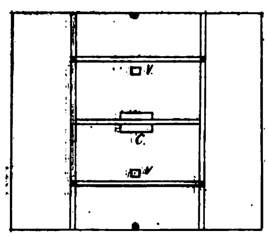
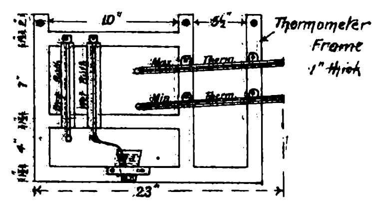

CENTRAL WEATHER BUREAU, MELBOURNE
THERMOMETER SCREEN (LARGE.)
Brass Hooks
Fig. 7
Fig. 8
Front
Side
Thermometer Stand Small Screen.
Fig. 1
Front Elevation.
Fig. 2
Section A B
Fig. 3
Section C.D.
Fig. 5.
Roof Details. Front and Side
Fig. 6
Fig 9
2" G Iron Legs Stays
Foot Plates Plan.
Fig. 4.
Plan.
H.A. Hunt,
Commonwealth Meteorologist.

PLATE E.



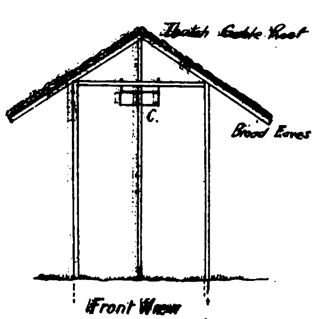
Plan.



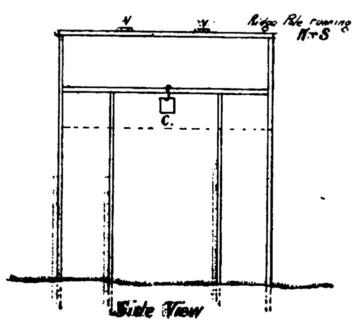
Sketch showing hut suitable for the proper exposure of Meteorological instruments in Tropical countries.

V. Ventilators in roof

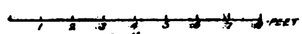
C. Wire cage containing instruments



Front View



Side View



Scale

PLATE F.

Thermometer Shelter for Tropical Countries.

In tropical countries the radiation from the sun is very intense during much of the day time. In consequence, not only does the thermometer screen itself become heated, but heat is reflected from patches of bare ground, walls, fences, &c. Thermometers in an ordinary Stevenson screen are, therefore, liable to record as much as several degrees too high. It is desirable in these regions to provide a more efficient and extensive protection from radiation than that afforded by a screen of the Stevenson type.

The heavy rains of the tropics are also a source of trouble, and protection from them is an advantage. The best shelter is that given by a thatched roof. One of circular design is very suitable, but the gable form is perhaps simpler to construct.

The hut illustrated on Plate F with the necessary specifications is of approved type.

The shelter should be on an open spot at a considerable distance from walls, fences, trees, &c., and must be well ventilated. The ground should be covered with grass or low shrubs. It should not be possible for sun or rain to reach the instruments. The construction may be of any suitable material available in the locality.

The roof rests on a frame supported by four posts standing 4 feet apart. Two additional posts, one at each end, lend support to the ridge beam, which should lie in a north and south direction. The roof at each end should project about 18 inches, and the eaves about 2 feet from the frame. Two ventilation holes (V.V.) are provided in the roof. The frame consists of four bars or rails connecting the posts, and on a cross-bar, lying east and west in the centre of the frame, is suspended the support for the thermometers. The gable ends may be permanently covered with matting or louvre work, so long as the free circulation of the air is not interfered with. The thatching may consist of grass, palm leaves, reeds, or any other vegetable material used locally for the purpose.

If the instruments are likely to be interfered with it is advisable to surround them with a wire netting cage, which can be kept locked.

The instruments should be fixed firmly so that the maximum and minimum thermometers may not be disturbed by vibration.

The support for the thermometer is illustrated in the upper right-hand diagram of the figure. The dry and wet bulb thermometers are hung on the left side on small double hooks. There should be a space of 3 inches between them, with the wet bulb on the right.

The glass water vessel for the wet bulb should be fixed to the wooden support so that the top is 2 inches to the right and 1 inch below the level of the bulb.

The maximum and minimum thermometers occupy the right hand half of the support in nearly horizontal positions, the bulb being about half an inch (½″) below the other end in each case. The maximum should be above and 3 or 4 inches away from the minimum.

Telegraphic Reports.

All telegrams should be lodged as soon as possible after the observations are made. The address should be "Weather" followed by the names of the cities in which the bureaux to which the message is to go are situated, e.g., "Weather, Hobart." "Weather, Perth, Adelaide, Melbourne, Sydney, Brisbane." If for any reason (e.g., Sunday observation sent on Monday) the telegram is not lodged on the day on which the observation is made, the date and time should be inserted thus "11th morning ....," "21st afternoon .....".

In general, the morning observation is made at 8 a.m. in Western Australia, at 8.30 a.m. in South Australia and the Northern Territory, and at 9 a.m. in the eastern States. All stations make the afternoon observation at 3 p.m. Special conditions obtain, however, at a number of stations, and separate instructions are given to meet these cases.

The order in which the information is arranged is as follows :—Barometer reading, dry bulb temperature, wet bulb temperature, maximum temperature, minimum temperature, terrestrial minimum temperature, wind direction, wind force, rainfall, cloud direction, present weather, past weather, and sea disturbance. Many telegrams will not, of course, contain the complete amount of information here listed; inland stations, for instance, can give no sea disturbance; the minimum temperature and the rainfall are not given on the 3 p.m. telegram; only a comparatively few stations have a terrestial minimum thermometer; and so on. Several coastal stations indicate the direction of the swell in addition to the sea disturbance. A few examples follow :—

(1) "Fidget tree transit trudge traitor traduce rattan five sadden less stun salvo NE."

(2) "Foist topic tone traduce tip ranker three adorn T salad lark star stun sabre" (no terrestrial minimum at station).

(3) "Felix touch tory toulon rarefy seven semi serio salon latin stun scant nose nabob" (3 p.m. report).

The interpretation of the above is as follows :—

(1) Barometer 29.57 inches, dry bulb 70°, wet bulb 64°, maximum 85°, minimum 62°, terrestrial minimum 58°, wind NW. force 5, sky three-quarter clouded but clouds chiefly high, middle layer (alto-cumulus or alto-stratus) clouds moving from WNW., lightning seen to NE. since last report.

(2) Barometer 30.17 inches, dry bulb 48°, wet bulb 44°, maximum 58°, minimum 34°, wind SW. 3, 19 points of tank rain, overcast with clouds chiefly low and moving from SW., hoar frost this morning, mainly clear since last report.

(3) Barometer 29.28 inches, dry bulb 52°, wet bulb 50°, maximum 53°, wind W. 7, squally and increasing, overcast and threatening, low clouds from W., heavy showers since last report, sea rather rough and rising.

Observers are particularly requested to give the past weather preceded by the code word "stun." Such phenomena especially as thunder, high winds, dust storm, fog, frost, or hail should be reported.

By dust storm is meant the severe dust storm as usually experienced in the interior and often connected with a line squall.

It is, of course, well known that as the trough or lowest pressure area of a barometric depression or "low" passes there is usually a more or less sudden change of wind from some northerly or north-westerly direction to one south of west accompanied by a drop in temperature. Sometimes the change approaches along a visible front and is marked by squalls which may be violent. In this case it is called a "line squall." A characteristic "roll cloud" usually forms along the squall line. It is a great aid to forecasting to know of the movement of a cool change or a line squall, and they should always be reported. If the change has not long preceded the observation the time at which it passed might be mentioned. Victorian and South Australian coastal stations are specially instructed to send an extra telegram when a change passes after a hot spell of some days.

The observers at some lighthouse stations make a practice of always including the word for mist or some other word denoting bad visibility in their telegrams. It is difficult to understand how prevarication of this kind can be of any assistance to the observer, and it is to be strongly deprecated. Some marine observers are inclined to exaggerate the sea disturbance. The term "high" should not be lightly used in describing the state of the sea. High seas are of very infrequent occurrence.

Great care should be exercised in transmitting messages over the telephone. Code words should all be spelt out.

BAROMETER CODE.

Bar.	Code Word.	Bar.	Code Word.	Bar.	Code Word.	Bar.	Code Word.
Inches.		Inches.		Inches.		Inches.	
29·00	Fatalism	29·45	Festive	29·90	Fitful	30·35	Forward
29·01	Fated	29·46	Festus	29·91	Fixed	30·36	Fragile
29·02	Father	29·47	Fetch	29·92	Flag	30·37	Fraud
29·03	Fathom	29·48	Fetid	29·93	Flagon	30·38	Frazer
29·04	Fatigue	29·49	Feudal	29·94	Flail	30·39	Freak
29·05	Fatling	29·50	Fever	29·95	Flake	30·40	Freckle
29·06	Faucet	29·51	Feverish	29·96	Flap	30·41	Freely
29·07	Faugh	29·52	Fez	29·97	Flatly	30·42	Freeman
29·08	Fault	29·53	Fiasco	29·98	Flaxen	30·43	French
29·09	Fauna	29·54	Fibrin	29·99	Fled	30·44	Frenzy
29·10	Faust	29·55	Fickle	30·00	Fleecy	30·45	Fresco
29·11	Favor	29·56	Fiddle	30·01	Fleeting	30·46	Friar
29·12	Fawn	29·57	Fidget	30·02	Flesh	30·47	Friction
29·13	Fay	29·58	Fido	30·03	Flexible	30·48	Friendless
29·14	Fayal	29·59	Fiducial	30·04	Fling	30·49	Frigate
29·15	Fayette	29·60	Fiendish	30·05	Flippant	30·50	Frigid
29·16	Fealty	29·61	Fierce	30·06	Flock	30·51	Frill
29·17	Fear	29·62	Fife	30·07	Florid	30·52	Fringe
29·18	Fearing	29·63	Fifth	30·08	Floss	30·53	Frisk
29·19	Feast	29·64	Figaro	30·09	Flown	30·54	Frit
29·20	Feather	29·65	Fight	30·10	Flue	30·55	Frog
29·21	Feature	29·66	Figment	30·11	Fluid	30·56	Frolic
29·22	Febrile	29·67	Figure	30·12	Flurry	30·57	Front
29·23	Federal	29·68	Filbert	30·13	Flute	30·58	Froth
29·24	Feeble	29·69	Filch	30·14	Foamy	30·59	Frown
29·25	Feed	29·70	Filibeg	30·15	Focal	30·60	Frozen
29·26	Feeding	29·71	Filigree	30·16	Focus	30·61	Frugal
29·27	Feline	29·72	Filing	30·17	Foist	30·62	Fudge
29·28	Felix	29·73	Fillet	30·18	Folio	30·63	Fuel
29·29	Felon	29·74	Film	30·19	Folks	30·64	Fugitive
29·30	Felony	29·75	Final	30·20	Fondle	30·65	Fugue
29·31	Female	29·76	Financial	30·21	Food	30·66	Fulcrum
29·32	Fence	29·77	Finch	30·22	Foppish	30·67	Fulfil
29·33	Fenian	29·78	Find	30·23	Foray	30·68	Fuller
29·34	Fennel	29·79	Finder	30·24	Forbid	30·69	Fully
29·35	Fenton	29·80	Finely	30·25	Forest	30·70	Fullness
29·36	Ferment	29·81	Finger	30·26	Forfeit	30·71	Fulsome
29·37	Fern	29·82	Finis	30·27	Forge	30·72	Furze
29·38	Ferret	29·83	Finish	30·28	Forgetable	30·73	Fuss
29·39	Ferrule	29·84	Finland	30·29	Forgive	30·74	Fustian
29·40	Ferrum	29·85	Finny	30·30	Formal		
29·41	Ferry	29·86	Firkin	30·31	Formed		
29·42	Fertile	29·87	Fiscal	30·32	Forth		
29·43	Festa	29·88	Fish	30·33	Fortune		
29·44	Festoon	29·89	Fit	30·34	Forum		

If the barometer reading does not fall within the range of the above table, the complete reading should be sent in figures, e.g., 28·32.

TEMPERATURE CODE.

Temp.	Code Word.	Temp.	Code Word.	Temp.	Code Word.	Temp.	Code Word.	Temp.	Code Word.
° F.		° F.		° F.		° F.		° F.	
0	Thaw	25	Tidy	50	Tory	75	Tribe	100	Turbine
1	That	26	Tiff	51	Total	76	Tribune	101	Turgid
2	Thebes	27	Tiger	52	Touch	77	Trick	102	Turkey
3	Thee	28	Time	53	Toulon	78	Trigger	103	Turn
4	Theft	29	Tindall	54	Towel	79	Trill	104	Turner
5	Thence	30	Ting	55	Town	80	Trio	105	Turtle
6	There	31	Tinker	56	Trace	81	Triplet	106	Tuscan
7	Thermo	32	Tinsel	57	Trade	82	Tripos	107	Tusk
8	Thesis	33	Tioga	58	Traduce	83	Trophy	108	Tutor
9	They	34	Tip	59	Traffic	84	Truant	109	Twain
10	Thibet	35	Tipton	60	Tragic	85	Trudge	110	Twenty
11	Thick	36	Titan	61	Trainer	86	Truly	111	Twig
12	Thief	37	Tivoli	62	Traitor	87	Trumpet	112	Twirl
13	Think	38	Toddy	63	Traject	88	Trust	113	Twist
14	Thomas	39	Toffee	64	Transit	89	Truth	114	Twixt
15	Thou	40	Toil	65	Trash	90	Tryst	115	Tybee
16	Thrash	41	Token	66	Travel	91	Tubby	116	Tycoon
17	Throat	42	Told	67	Tray	92	Tuft	117	Tyler
18	Throb	43	Tomb	68	Treat	93	Tug	118	Tymbal
19	Throng	44	Tone	69	Treble	94	Tumble	119	Type
20	Throw	45	Tonic	70	Tree	95	Tump	120	Typic
21	Thrum	46	Topaz	71	Trend	96	Tunis	121	Tyrant
22	Thyme	47	Topeka	72	Trepan	97	Tunnel	122	Tyrian
23	Tick	48	Topic	73	Trespass	98	Turban	123	Tyro
24	Tide	49	Torpid	74	Trial	99	Turbid	124	Tyrol

WIND CODE.

Direction.	Code Word.	Force.	Description.	Miles per Hour.
N.	Rabble	1	Light air ...	2
N.N.E.	Racket	2	Slight breeze ...	5
N.E.	Radiant ...	3	Gentle breeze ..	10
E.N.E.	Radix	4	Moderate breeze ..	15
E.	Rag	5	Fresh breeze ..	21
E.S.E.	Raise	6	Strong breeze ..	27
S.E.	Rally	7	High wind ..	35
S.S.E.	Ramp	8	Gale	42
S.	Ranche ..	9	Strong gale ..	50
S.S.W.	Ransom ..	10	Whole gale ..	59
S.W.	Ranker	11	Storm	68
W.S.W.	Rapid	12	Hurricane ..	Above 75
W.	Rarefy			
W.N.W.	Rascal			
N.W.	Rattan			
N.N.W.	Razor			
Calm	Reap			

The number for the force of the wind should be written in full after the code word for the direction, e.g., NW. 6 should be sent as "Rattan six."

RAINFALL CODE.

Points.	Code Word.	Points.	Code Word.	Points.	Code Word.	Points.	Code Word.
0	Ab	30	Agate	60	Alum	90	Apprise
1	Abase	31	Agatha	61	Amass	91	Apron
2	Abbot	32	Aged	62	Amaze	92	Aqua
3	Abet	33	Agent	63	Amber	93	Arab
4	Abide	34	Agile	64	Amble	94	Arcade
5	Able	35	Aglow	65	Amen	95	Arch
6	Absent	36	Ague	66	Amid	96	Ardent
7	Abyss	37	Ahead	67	Amiss	97	Ardor
8	Ache	38	Aid	68	Ammon	98	Argill
9	Acme	39	Ajar	69	Ample	99	Argus
10	Act	40	Akin	70	Anchor	100	Babel
11	Active	41	Alas	71	Ancient	200	Balm
12	Actor	42	Alba	72	Angel	300	Barge
13	Acute	43	Album	73	Angry	400	Bask
14	Adapt	44	Alcove	74	Anise	500	Bay
15	Aden	45	Alert	75	Ankle	600	Beard
16	Adieu	46	Alibi	76	Annex	700	Beat
17	Admire	47	Alike	77	Annoy	800	Belch
18	Admit	48	Allay	78	Annul	900	Bell
19	Adorn	49	Allege	79	Anthem	1,000	Bengal
20	Adri	50	Allude	80	Antic	1,100	Bind
21	Adrift	51	Alma	81	Anvil	1,200	Blame
22	Adult	52	Alms	82	Any	1,300	Bled
23	Advise	53	Aloe	83	Apart	1,400	Blight
24	Afar	54	Aloft	84	Ape	1,500	Bloom
25	Affix	55	Along	85	Apex	1,600	Blush
26	Afraid	56	Aloud	86	Apish	1,700	Body
27	Afrit	57	Alpha	87	Appeal	1,800	Bold
28	Afront	58	Alps	88	Append	1,900	Brace
29	Again	59	Also	89	Apply	2,000	Brute

If the rain exceeds 100 points, it is to be sent in two words ; for instance, 281 points is to be telegraphed as " Balm Anvil."

When rains have fallen in country districts, particularly when moderate amounts only have been recorded, the effect of the rain will depend on the way in which it has fallen. If, for instance, the fall has been rapid, even so small an amount as 10 points may cause a considerable run-off into streams, tanks, or dams, and thus provide valuable supplies for watering stock. On the other hand, 50 points or more falling as a light rain spread over a large part of a day may cause practically no run-off. In the latter case there would be no important addition to water storages, but the growth of feed may be maintained for a further period or the wheat yield be considerably increased. Business men are consequently anxious to have some indication of the nature of the rainfall telegraphed, as well as its amount.

Country observers are, therefore, requested, whenever they think that they can usefully do so, to classify rainfall in their telegraphic reports as Pastoral, Tank, or Pastoral and Tank, by inserting after the amount the letters P, T, or PT respectively. In some cases the rains, though heavy, may be in the form of isolated showers which may fill storage basins but not be sufficiently general to be of much value for producing feed.

A certain number of observers have been requested to send a special telegram at 6 p.m. reporting the amount of rainfall between 9 a.m. and 6 p.m. on days when any has fallen. These observers are reminded of the request and urged to send their reports regularly.

WEATHER CODE.

	Code Word.	Description.
Without Precipitation.	Sabre ..	Clear, *i.e.*, sky less than 2 tenths clouded
	Sacred ..	Quarter clouded, *i.e.*, sky 2 to 3 tenths clouded
	Sad ..	Half clouded, *i.e.*, sky 4 to 6 tenths clouded
	Sadden ..	Three-quarter clouded, *i.e.*, sky 7 to 8 tenths clouded, but clouds chiefly high (Cirrus or Alto clouds)
	Safe ..	Three-quarter clouded, *i.e.*, sky 7 to 8 tenths clouded, but clouds chiefly low (Cumulus, Strato-Cumulus, &c.)
	Sago ..	Overcast, *i.e.*, sky 9 to 10 tenths clouded, but clouds chiefly high
	Salad ..	,, ,, ,, ,, but clouds chiefly low
	Salon ..	Overcast and dull or threatening
	Salt ..	Sky not overcast at station, but conditions threatening in........ (here give direction in letters, *e.g.*, NW.)
	Salvo ..	Distant lightning seen to............ (add direction as above)
	Sambo ..	Thunder, or thunder and lightning, but no rain
With Precipitation.	Sand ..	Misty rain
	Sandal ..	Light rain or drizzle
	Sara ..	Steady rain
	Satan ..	Heavy, steady rain
	Save ..	Passing showers
	Scalp ..	Frequent showers
	Scant ..	Heavy showers
	Scoop ..	Snow or snow and rain
	Score ..	Hail or hail and rain
	Scull ..	Raining, with lightning visible in distance
	Search ..	Thunderstorm, with light rain
	Sect ..	,, with heavy rain
	Seize ..	,, with hail or hail and rain
Winds.	Semi ..	Squally
	Sepia ..	Heavy squalls
	Serio ..	Wind force increasing
	Septic ..	Wind force decreasing
	Sex ..	Hot wind
	Shin ..	Cool change
	Shiver ..	Line squall
Atmosphere.	Side ..	Smoke haze
	Sink ..	Haze
	Sirup ..	Mist
	Slam ..	Thin fog
	Slice ..	Fog of moderate intensity (visibility less than 1¼ miles)
	Slip ..	Dense fog (visibility less than 220 yards)
	Sly ..	Dust storm
	Sock ..	Sultry
Miscellaneous	Song ..	Heavy dew this morning
	Star ..	Hoar frost this morning
	Stun ..	Since previous report

More than one code word should be used if necessary. The following are examples :—

Sadden serio stun salvo NW. = Sky three-quarter clouded, but clouds chiefly high; wind force increasing; lightning seen to the north-west since last report

Sabre star = Clear; hoar frost this morning

Semi scan scull = Squally, with heavy showers; lightning visible in distance

CLOUD CODE.

Clouds Moving from—	deg.	Upper Clouds. Cirrus, Cirro-Stratus, and Cirro-Cumulus.	Middle. Alto-Cumulus, Alto Stratus.	Lower. Cumulus, Strato-Cumulus, &c.
N.	360	Loam	Leaf	Lace
N.N.E.	22½	Lobby	League	Lack
N.E.	45	Local	Leak	Lady
E.N.E.	67½	Lock	Learn	Lag
E.	90	Lodge	Lease	Lagoon
E.S.E.	112½	Lofty	Ledge	Lamp
S.E.	135	Loin	Left	Lance
S.S.E.	157½	Long	Leg	Lapel
S.	180	Lop	Legal	Larder
S. by W.	191¼	Lopper	Legate	
S.S.W.	202½	Lord	Legend	Large
S.W. by S.	213¾	Lordly	Legion	
S.W.	225	Lorry	Lemon	Lark
S.W. by W.	236¼	Losing	Lender	
W.S.W.	247½	Loss	Lent	Lash
W. by S.	258¾	Loth	Lenten	
W.	270	Loud	Leo	Latin
W. by N.	281¼	Louder	Leonard	
W.N.W.	292½	Love	Less	Launch
N.W. by W.	303¾	Loving	Lesson	
N.W.	315	Lowland	Letter	Lava
N.W. by N.	326¼	Lowness	Lettuce	
N.N.W.	337½	Loyal	Level	Lawn
N. by W.	348¾	Lozenge	Levy	

The directions in the second column are given from north round by east through 360 degrees.

CODE FOR SEA DISTURBANCE.

Scale Number.	Description.	Code Word.	Scale Number.	Description.	Code Word.
	Sea Rising	Nabob	4	Moderate	Nice
	Sea Moderating	Nadir	5	Rather rough	Nose
0	Calm	Nag	6	Rough	Not
1	Very Smooth	Neck	7	High	Noun
2	Smooth	Need	8	Very high	Novel
3	Slight	Nest	9	Phenomenal	Nude

Two words may be used if necessary, *e.g.*, Nose nabob = sea rather rough and rising.

PART IV.

Meteorological Tables.

Wherever possible the tables which follow are in conformity with the International Tables published in accordance with the resolutions adopted by the International Congress of Meteorologists in Rome in 1879. The tables have to a large extent been abstracted from various editions of the *Observer's Handbook*, M.O., London, 191, up to that for 1921. Table VI., however, is derived from the publications of the Indian Meteorological service.

Tables I. to IV.—Conversion of measurements of distance and wind velocity from English to metric units and vice versa are based on the relation—

1 inch = 25.4000 millimetres.

Tables V. and VI.—Humidity Tables.—The saturation pressures of water vapour at different temperatures in Table V. are derived from the International Tables. Pressures are given for each whole degree from 0° F. to 32° F., and from 95° F. to 120° F., while for the intermediate range they are given for each fifth of a degree.

Table VI. gives the vapour pressures and the relative humidity corresponding to various dry and wet bulb temperatures for a pressure of 29.7 inches of mercury as published in the "Tables for the Reduction of Meteorological Observations made in India," 1910.

The dry and wet bulb psychrometer in the Stevenson screen is in very general use for the determination of the humidity of the air because of its cheapness and simplicity, and because it gives results of fair accuracy. It is, however, open to a number of serious disabilities. The water must be pure or the pressure of the vapour over it will be affected and the results vitiated. Again, until the velocity of the air current past the wet bulb reaches a certain minimum value the degree to which its temperature is depressed will increase with the velocity of this current. Professor Pernter divided the possible conditions into three groups and derived formulae for reducing the readings of the dry and wet bulb thermometers under the three classes of conditions. The formulae are as follows :—

$$(1)\quad e'' = e' - \cdot 00067\, B\,(t - t')\left(1 + \frac{t' - 32}{1098}\right)$$

$$(2)\quad e'' = e' - \cdot 00044\, B\,(t - t')\left(1 + \frac{t' - 32}{1098}\right)$$

$$(3)\quad e'' = e' - \cdot 000364\, B\,(t - t')\left(1 + \frac{t' - 32}{1098}\right)$$

Where e'' and e' are the saturation pressures of water vapour at the dew point and at the temperature of the wet bulb, e'' is, of course, also the existing vapour pressure; t and t' are the dry and wet bulb temperatures respectively in degrees Fahrenheit; B is the reading of the barometer at the station level and in the same units as e'' and e'.

Formula (1) is for use in a calm (wind inside screen containing thermometers not more than 1 mile per hour). It is suitable also for use with a psychrometer in an ordinary room when fanning is not resorted to. The second formula is for use when there is a slight wind blowing in the screen and the third when the wind is 6 miles per hour or more. The first and third thus apply to definite and constant conditions as regards the relative readings of the dry and wet bulb, while the second is a mean value for a certain range of conditions.

The constants in the equations refer to a wet bulb covered with water; if the water on the bulb be frozen the coefficients of the second terms become ·00059, ·00039, and ·00032 respectively.

The tables used in India are based on the formula :—

$$e'' = e' - \cdot 000437\, B\,(t - t')\left(1 + \frac{t' - 32}{1098}\right)$$

which it will be seen is practically identical with Pernter's formula for light winds.

In the United States the humidity is determined by means of a sling psychrometer, which is whirled by hand at the rate of about one revolution per second. The conditions thus correspond closely with those to which Pernter's third or strong wind formula is applicable. The American formula is, in fact, almost identical with Pernter's, being—

$$e'' = e' - \cdot 000367\, B\,(t - t')\left(1 + \frac{t - t'}{1571}\right)$$

It is not feasible to keep a record of the wind velocity in the screen and vary the formula used in accordance therewith. In practice, therefore, when the humidity is derived from a dry and wet bulb hygrometer in a screen it becomes a matter of selecting the formula most generally applicable. The plan of using Pernter's light wind formula or one of the very nearly equivalent variations is being more and more widely adopted. Thus the Indian tables are used in Australia. If Assmann's ventilated psychrometer is used the observations should be reduced by means of Pernter's strong wind formula. When the temperature falls below 32° F. conditions become complicated, and considerable care is needed if accurate results are to be obtained. For cases in which the wet bulb reads 32°F. or below, the tables apply to conditions in which the wet bulb is covered with ice. e'' then refers to vapour pressure over water (which is greater than that over ice at the same temperature) and e' to that over ice, while the co-efficient is reduced to .000395.

For high temperatures and low humidities the error due to using the light wind formula may become considerable. In fact, further

investigation is needed into the behaviour of the wet and dry bulb hygrometer under these conditions. Fortunately, on the occasions on which they occur the wind is most often light. The error in the relative humidity is not important, but that in the vapour pressure may be so.

Table VI. (a).—It will be seen from the psychrometer formula that for any particular values of the temperature and humidity the reading of the wet bulb will depend on the pressure. The Indian tables give the humidity for various pressures. Table VI. gives values for 29.7 inches only, and the error caused by using this table for high-level stations may be considerable, and would be systematic. In order to keep the volume of the tables within reasonable bounds, instead of repeating Table VI. for different pressures, Table VI. (a)., which gives a subsidiary correction for pressure, has been constructed. The correction has been calculated from the equation :—

$$\text{Correction} = + \cdot 00044\, p\,(t - t')$$
$$\text{where } p = 29 \cdot 7 - \text{actual pressure in inches.}$$

The correction will be positive if the pressure is below and negative if it is above 29·7 inches.

Example :—

Station level pressure	=	27·5″
Dry bulb temperature	=	80·4°
Wet bulb temperature	=	65·3°
Table VI. gives—pressure of water vapour	=	·421 inches.
From Table VI (a)., correction for pressure	=	·015 inches.
Corrected pressure of water vapour	=	·436 inches.

Table VI (b). facilitates the computation of the correction to the relative humidity corresponding to the correction to the absolute humidity as given by Table VI (a). The correction will be of the same sign as that from Table VI (a). The table gives the amount of vapour pressure sufficient to produce a change of 1 per cent. in the relative humidity at various temperatures. The required correction is obtained by dividing the correction derived from Table VI (a). by this quantity.

Example :—In the case dealt with in the preceding example, the temperature is 80.4° ; therefore, a change of 1 per cent. in the relative humidity is produced by 0.010 inch. The correction from Table VI (a). is 0.015 inch, and the relative humidity correction consequently 1.5 per cent. or 2 per cent. approximately. Table VI. gives the humidity as 40 per cent. and the corrected value is therefore 42 per cent.

The dew point is the temperature at which the amount of vapour present in the atmosphere would be sufficient to produce saturation, and the vapour pressure having been found (from Table VI.), the dew point can be obtained from Table V., e.g., in the previous example the vapour pressure is 0.436 inches, which would produce saturation at 55.3°, which is therefore the dew point.

Tables VII.-IX.—Barometer Tables (English Units).

Table VII (a). gives the correction for temperature to readings of barometers of the Fortin pattern. The table applies to barometers with brass scales extending from the cistern to the top of the mercury. The standard temperatures are 32° F. for the mercury and 62° F. for the brass scale, the reduction formula being :—

$$\text{Correction} = H \frac{\mu (t - 32) - \lambda (t - 62)}{1 + \mu (t - 32)}$$

Where H = height of the barometer as read.

t = temperature of attached thermometer in degrees Fahrenheit.

μ = coefficient of expansion of mercury per degree Fahrenheit taken as 0·0001010.

λ = coefficient of linear expansion of brass per degree Fahrenheit taken as 0·0000102.

For all temperatures above 28.5° F. the correction is to be subtracted from the observed reading.

Table VII (b). is the corresponding table for the Kew pattern barometer and is applicable only to mercurial barometers of that pattern graduated in inches and with brass scales extending from the cistern to the top of the mercury. The formula for this table is :—

$$\text{Correction} = H \frac{\mu (t - 32) - \lambda (t - 62)}{1 + \mu (t - 32)} + \frac{V}{A} (\mu - 3\eta)(t - 62)$$

Where V = Total volume of mercury in the barometer under standard conditions.

A = Effective internal area of cross-section of cistern.

η = Composite mean between the coefficients of expansion of iron, brass, and glass. The last material enters into the calculation to a very minor extent. For the present standard Kew Pattern barometer η = ·0000056.

The other quantities have the same significance as previously.

It is only recently that it has been realized that a special formula is necessary for the reduction of observations with the Kew pattern barometer with the consequent introduction of the second term into the above formula. The correction allows for the effect of temperature on the depth of the mercury in the cistern (for a fuller discussion see the *Dictionary of Applied Physics*, Vol. III., p. 152). The quantities given in the table are to be subtracted from the observed reading.

Table VIII. contains the corrections required to reduce barometer readings in various latitudes to the standard gravity at sea level in latitude 45°. The correction is computed by means of the formula :—

$$H_1 = H\,(1-0\cdot00259 \cos 2\lambda)$$

where H = observed reading of barometer reduced to sea level and corrected for temperature in latitude λ.

H_1 = above reading at standard gravity.

The correction is subtractive for latitudes less than 45° in either hemisphere and additive for latitudes greater than 45°. The correction is given for each degree of latitude and for pressures of 30 inches and 27 inches respectively.

Table IX., for the reduction of barometer readings to mean sea level is in accordance with the International Tables, Chapter IV., Section II., pp. 32–51, and Table VIII., pp. 208–227.

The complete formula for reducing barometer readings to mean sea level is :—

$$Z=60368\cdot6\,[1\cdot00157+0\cdot002039\,(\theta-32)]\left(1+\frac{Z}{20902950}\right)\left(\frac{1}{1-0\cdot378\frac{\phi}{\eta}}\right)$$

$$\times\ (1+0\cdot00259 \cos 2\lambda)\log\frac{H_0}{H}\ .$$

where Z = height of station above mean sea level in feet.

θ = mean temperature in degrees Fahrenheit of an air column Z feet in height such as would be expected to lie between the station and sea level were that space not occupied by land.

ϕ = mean pressure of aqueous vapour in the above air column.

η = mean pressure of air in the column.

λ = latitude.

H = barometer reading at the station corrected for temperature and to standard gravity.

H_0 = above pressure reduced to sea level.

If the station is in the air, e.g., on an air vessel or on a balloon or kite meteorograph above a surface at sea level, or nearly so, the above quantities have a precise significance. Even in such a case, however, they can usually only be determined approximately. In the case of an elevated land station the underlying air column is, of course, an imaginary one, and the values assigned to its humidity and temperature fictitious. However, for the synoptic weather chart and for some other purposes it is often required to apply a correction to the barometer reading so as to make it comparable with sea level readings at other stations. It is, therefore, necessary to assign the most suitable values to the various terms. The theoretical limitations of the correction must, however, be borne in mind, and it should not occasion surprise if apparently anomalous results are deduced from high-level stations.

The first term in brackets provides the correction to the pressure of the air column for the departure of its mean temperature from the standard value, the second for the variation of gravity with height, the third for the presence of aqueous vapour, which is less dense than air, and the fourth for variation of gravity with latitude.

At a meeting of Directors of Meteorological Institutes and Observatories held at Innsbruck in 1905, it was agreed that the reduction of barometric readings to mean sea level should be carried out in such a manner that the final results should not differ by more than 0.3 millimetre (0.012 inch) from those which would be given by the above formula,

(1) If the humidity at the time of observing be taken as the mean humidity, ϕ, of the air column.

(2) If the mean temperature of the air column be computed from the temperature at the time of observing and a vertical temperature gradient (lapse rate) of 0.5° C. per 100 metres, or 1° F. per 300 feet.

(3) If we disregard the effect of the variation of gravity with latitude in the correction.

It can be shown that for altitudes up to 1,000 feet we obtain results usually within the limits of accuracy laid down in the above resolution (1) if we omit the term referring to humidity, and (2) if we adopt the dry bulb reading at the time of observation for the temperature of the air column and neglect the vertical temperature gradient.

Thus simplified the formula becomes :—

$$Z = 60368 \cdot 6\,[1 \cdot 00157 + 0 \cdot 002039\,(\theta - 32)]\left(1 + \frac{Z}{20902950}\right)\log \frac{H_0}{H}$$

which may be written

$$\frac{Z}{56525 + 123 \cdot 1\theta + 0 \cdot 003Z} = \log \frac{H_0}{H}$$

$$\text{Let } \log \frac{H_0}{H} = m$$

$$\text{then } (10^m - 1) = \frac{H_0 - H}{H}$$

$$\text{Again let } (10^m - 1) = M$$

$$\text{then } MH = H_0 - H$$

H_0—H is the amount which must be added to the observed reading, corrected for temperature, to reduce it to mean sea level.

The tables published by the International Committee give values of $1{,}000 \times M$ to the nearest 0.1, for increments of altitude of 50 feet and increments of temperature of 5° F. By multiplying these values by H, the observed height of the barometer (corrected for temperature) and dividing by 1,000, the required increment can be found with a maximum error of 0.0015 inch.

Table IX. has been deduced in this manner from the values of 1,000 $\times$M, interpolations being made where necessary. It gives the amount of the correction, for barometer readings at station level of 27 and 30 inches respectively, for every 10 feet of altitude up to 1,000 feet and for intervals of temperature of 10° F. between 0° and 90° F. The correction is to be added to the station level reading.

It must be remembered that while the reading of the attached thermometer is used for obtaining the temperature correction to the barometer, the temperature of the *dry bulb in the screen* must be used for the sea level correction.

For altitudes greater than 1,000 feet the International Tables should be consulted.

Table X. is for the conversion of pressures expressed in inches into millibars, and vice versa.

Tables XI., A—E.—For reduction of readings of barometers graduated in millibars.

Table A gives temperature corrections for Fortin barometers for given differences between the temperature of the attached thermometer, and the fiducial temperature. The fiducial temperature is that at which the barometer reads correctly in millibars at the station. The correction is given by the formula :—

$$p - p_1 = ap_1 (t_0 - t_1)$$

where p = required reading in millibars.
p_1 = barometer reading.
t_0 = fiducial temperature in degrees absolute.
t_1 = reading of attached thermometer.

If the attached thermometer has an error, its readings should, of course, be corrected for that error.

Table B is the temperature correction table for Kew pattern barometers, the formula being—

$$p - p_1 = (ap_1 + \beta) (t_0 - t_1)$$

The term β has already been referred to, and depends on the dimensions of the barometer.

Table C gives the corrections on account of variation of gravity with latitude to be applied to standard temperatures to derive fiducial temperatures. The correction t is given by the formula :—

$$\frac{g - g_{45}}{g_{45}} p = ap_1 t\text{—for Fortin barometers}$$

$$\frac{g - g_{45}}{g_{45}} p = (ap_1 + \beta) t\text{—for Kew pattern barometers}$$

where p and p_1 may be taken as 1000mb.

$a = \mu - \lambda$ and is equal to 0·000163 per degree absolute for a barometer with a brass frame.

β is a quantity depending on the dimensions of the barometer.

Tables D and E give the reduction of pressure to mean sea level, and are derived in a similar manner to Table IX. for British units.

TABLE I.—CONVERSION OF METRES TO FEET.

1 metre = 3·28084 feet.

Metres.	0	1	2	3	4	5	6	7	8	9
	Feet.									
0	0·00	3·28	6·56	9·84	13·12	16·40	19·68	22·97	26·25	29·53
10	32·81	36·09	39·37	42·65	45·93	49·21	52·49	55·77	59·06	62·34
20	65·62	68·90	72·18	75·46	78·74	82·02	85·30	88·58	91·86	95·14
30	98·43	101·71	104·99	108·27	111·55	114·83	118·11	121·39	124·67	127·95
40	131·23	134·51	137·80	141·08	144·36	147·64	150·92	154·20	157·48	160·76
50	164·04	167·32	170·60	173·88	177·17	180·45	183·73	187·01	190·29	193·57
60	196·85	200·13	203·41	206·69	209·97	213·25	216·54	219·82	223·10	226·38
70	229·66	232·94	236·22	239·50	242·78	246·06	249·34	252·62	255·91	259·19
80	262·47	265·75	269·03	272·31	275·59	278·87	282·15	285·43	288·71	291·99
90	295·28	298·56	301·84	305·12	308·40	311·68	315·96	318·24	321·52	324·80
100	328·08	331·36	334·65	337·93	341·21	344·49	347·77	351·05	354·33	357·61
200	656·17	659·44	662·73	666·01	669·29	672·57	675·85	679·13	682·41	685·70
300	984·25	987·53	990·81	994·09	997·38	1000·66	1003·94	1007·22	1010·50	1013·78
400	1312·34	1315·62	1318·90	1322·18	1325·46	1328·74	1332·02	1335·30	1338·58	1341·86
500	1640·42	1643·70	1646·98	1650·26	1653·54	1656·82	1660·11	1663·39	1666·67	1669·95
600	1968·50	1971·78	1975·07	1978·35	1981·63	1984·91	1988·19	1991·47	1994·75	1998·03
700	2296·59	2299·87	2303·15	2306·43	2309·71	2312·99	2316·27	2319·55	2322·83	2326·12
800	2624·67	2627·95	2631·23	2634·51	2637·80	2641·08	2644·36	2647·64	2650·92	2654·20
900	2952·76	2956·04	2959·32	2962·60	2965·88	2969·16	2972·44	2975·72	2979·00	2982·28
1,000	3280·84	3284·12	3287·40	3290·68	3293·96	3297·24	3300·53	3303·81	3307·09	3310·37

TABLE II.—CONVERSION OF FEET TO METRES.

1 foot = ·304800 metres.

Feet.	0	1	2	3	4	5	6	7	8	9
	Metres.									
0	0·000	0·305	0·610	0·914	1·219	1·524	1·829	2·134	2·438	2·743
10	3·048	3·353	3·658	3·962	4·267	4·572	4·877	5·182	5·486	5·791
20	6·096	6·401	6·706	7·010	7·315	7·620	7·925	8·230	8·534	8·839
30	9·144	9·449	9·754	10·058	10·363	10·668	10·973	11·278	11·582	11·887
40	12·192	12·497	12·802	13·106	13·411	13·716	14·021	14·326	14·630	14·935
50	15·240	15·545	15·850	16·154	16·459	16·764	17·069	17·374	17·678	17·983
60	18·288	18·593	18·898	19·202	19·507	19·812	20·117	20·422	20·726	21·031
70	21·336	21·641	21·946	22·250	22·555	22·860	23·165	23·470	23·774	24·079
80	24·384	24·689	24·994	25·298	25·603	25·908	26·213	26·518	26·822	27·127
90	27·432	27·737	28·042	28·346	28·651	28·956	29·261	29·566	29·870	30·175
100	30·480	30·785	31·090	31·394	31·699	32·004	32·309	32·614	32·918	33·223
200	60·960	61·265	61·570	61·874	62·179	62·484	62·789	63·094	63·398	63·703
300	91·440	91·745	92·050	92·354	92·659	92·964	93·269	93·574	93·878	94·183
400	121·920	122·225	122·530	122·834	123·139	123·444	123·749	124·054	124·358	124·663
500	152·400	152·705	153·010	153·314	153·619	153·924	154·229	154·534	154·838	155·143
600	182·880	183·185	183·490	183·794	184·099	184·404	184·709	185·014	185·318	185·623
700	213·360	213·665	213·970	214·274	214·579	214·884	215·189	215·494	215·798	216·103
800	243·840	244·145	244·450	244·754	245·059	245·364	245·669	245·974	246·278	246·583
900	274·320	274·625	274·930	275·234	275·539	275·844	276·149	276·454	276·758	277·063
1,000	304·800	305·105	305·410	305·714	306·019	306·324	306·629	306·934	307·238	307·543

TABLE III.—WIND VELOCITY.

CONVERSION OF METRES PER SECOND TO STATUTE MILES PER HOUR.

Metres per Second.	0	1	2	3	4	5	6	7	8	9
	Miles per Hour.									
0	0·0	2·2	4·5	6·7	8·9	11·2	13·4	15·7	17·9	20·1
10	22·4	24·6	26·8	29·1	31·3	33·5	35·8	38·0	40·3	42·5
20	44·7	47·0	49·2	51·5	53·7	55·9	58·2	60·4	62·6	64·9
30	67·1	69·3	71·6	73·8	76·1	78·3	80·5	82·8	85·0	87·2
40	89·5	91·7	93·9	96·2	98·4	100·7	102·9	105·1	107·4	109·6
50	111·8	114·1	116·3	118·6	120·8	123·0	125·3	127·5	129·7	132·0
60	134·2	136·5	138·7	140·9	143·2	145·4	147·6	149·9	152·1	154·3
70	156·6	158·8	161·1	163·3	165·5	167·8	170·0	172·2	174·5	176·7
80	179·0	181·2	183·4	185·7	187·9	190·1	192·4	194·6	196·9	199·1
90	201·3	203·6	205·8	208·0	210·3	212·5	214·7	217·0	219·2	221·4

TABLE IV.—WIND VELOCITY.

CONVERSION OF STATUTE MILES PER HOUR INTO METRES PER SECOND.

1 mile per hour = 0·4470 metres per second.

Miles per Hour.	0	1	2	3	4	5	6	7	8	9
	Metres per Second.									
0	0·0	0·5	0·9	1·3	1·8	2·2	2·7	3·1	3·6	4·0
10	4·5	4·9	5·4	5·8	6·3	6·7	7·2	7·6	8·1	8·5
20	8·9	9·4	9·8	10·3	10·7	11·2	11·6	12·1	12·5	13·9
30	13·4	13·9	14·3	14·8	15·2	15·7	16·1	16·5	17·0	17·4
40	17·9	18·3	18·8	19·2	19·7	20·1	20·6	21·0	21·5	21·9
50	22·4	22·8	23·3	23·7	24·1	24·6	25·0	25·5	26·0	26·4
60	26·8	27·3	27·7	28·2	28·6	29·1	29·5	30·0	30·4	30·9
70	31·3	31·7	32·2	32·6	33·1	33·5	34·0	34·4	34·9	35·3
80	35·8	36·2	36·7	37·1	37·6	38·0	38·4	38·9	39·3	39·8
90	40·2	40·7	41·1	41·6	42·0	42·5	42·9	43·4	43·8	44·3
100	44·7	45·2	45·6	46·0	46·5	46·9	47·4	47·8	48·3	48·7
110	49·2	49·6	50·1	50·5	51·0	51·4	51·9	52·3	52·8	53·2
120	53·6	54·1	54·5	55·0	55·4	55·9	56·3	56·8	57·2	57·7
130	58·1	58·6	59·1	59·5	59·9	60·4	60·8	61·2	61·7	62·1
140	62·5	63·0	63·5	63·9	64·4	64·8	65·3	65·7	66·2	66·6

TABLE V.

Saturation Pressure of Water Vapour

(*a*) In Inches of Mercury at 32° F. in Latitude 45° at Sea Level; (*b*) in Millibars.

°F.	Inches.	Milli-bars.	°F.	Inches.	Milli-bars.	°F.	Inches.	Milli-bars.	°F.	Inches.	Milli-bars.
..	..	..	35·0	0·203	6·86	45·0	0·298	10·10	55·0	0·432	14·64
..	..	..	·2	·204	6·92	·2	·301	10·18	·2	·435	14·74
..	..	..	·4	·206	6·98	·4	·303	10·26	·4	·438	14·85
0	0·045	1·52	·6	·208	7·03	·6	·305	10·34	·6	·442	14·96
1	·047	1·59	·8	·209	7·09	·8	·308	10·42	·8	·445	15·07
2	·049	1·67	36·0	·211	7·14	46·0	·310	10·49	56·0	·448	15·18
3	·052	1·75	·2	·212	7·20	·2	·312	10·57	·2	·451	15·29
4	·054	1·83	·4	·214	7·25	·4	·315	10·65	·4	·455	15·40
5	·057	1·92	·6	·216	7·31	·6	·317	10·73	·6	·458	15·51
6	·059	2·01	·8	·218	7·37	·8	·319	10·81	·8	·461	15·62
7	·062	2·10	37·0	·219	7·43	47·0	·322	10·90	57·0	·465	15·73
8	·065	2·20	·2	·221	7·49	·2	·324	10·98	·2	·468	15·84
9	·068	2·30	·4	·223	7·55	·4	·327	11·06	·4	·471	15·96
10	·071	2·40	·6	·224	7·61	·6	·329	11·15	·6	·475	16·07
11	·074	2·51	·8	·226	7·66	·8	·332	11·23	·8	·478	16·19
12	·078	2·63	38·0	·228	7·72	48·0	·334	11·31	58·0	·481	16·31
13	·081	2·75	·2	·230	7·79	·2	·337	11·40	·2	·485	16·42
14	·085	2·87	·4	·232	7·85	·4	·339	11·49	·4	·488	16·54
15	·088	3·00	·6	·233	7·91	·6	·342	11·57	·6	·492	16·66
16	·092	3·13	·8	·235	7·97	·8	·344	11·65	·8	·495	16·78
17	·096	3·27	39·0	·237	8·03	49·0	·347	11·74	59·0	·499	16·90
18	·101	3·41	·2	·239	8·09	·2	·349	11·83	·2	·502	17·02
19	·105	3·56	·4	·241	8·15	·4	·352	11·92	·4	·506	17·14
20	·110	3·71	·6	·243	8·22	·6	·355	12·01	·6	·510	17·26
21	·114	3·87	·8	·245	8·28	·8	·357	12·10	·8	·513	17·39
22	·119	4·04	40·0	·246	8·35	50·0	·360	12·19	60·0	·517	17·51
23	·124	4·21	·2	·248	8·41	·2	·362	12·28	·2	·521	17·63
24	·130	4·39	·4	·250	8·48	·4	·365	12·37	·4	·524	17·76
25	·135	4·58	·6	·252	8·55	·6	·368	12·46	·6	·528	17·89
26	·141	4·77	·8	·254	8·61	·8	·371	12·55	·8	·532	18·01
27	·147	4·97	41·0	·256	8·68	51·0	·373	12·64	61·0	·536	18·14
28	·153	5·18	·2	·258	8·74	·2	·376	12·74	·2	·539	18·27
29	·159	5·40	·4	·260	8·81	·4	·379	12·83	·4	·543	18·40
30	·166	5·62	·6	·262	8·88	·6	·382	12·93	·6	·547	18·53
31	·173	5·85	·8	·264	8·95	·8	·384	13·02	·8	·551	18·66
32·0	·180	6·09	42·0	·266	9·01	52·0	·387	13·12	62·0	·555	18·79
·2	·181	6·14	·2	·268	9·08	·2	·390	13·22	·2	·559	18·92
·4	·183	6·19	·4	·270	9·15	·4	·393	13·31	·4	·563	19·06
·6	·184	6·24	·6	·272	9·22	·6	·396	13·41	·6	·567	19·19
·8	·186	6·29	·8	·274	9·29	·8	·399	13·51	·8	·571	19·33
33·0	·187	6·34	43·0	·277	9·37	53·0	·402	13·61	63·0	·575	19·46
·2	·189	6·39	·2	·279	9·44	·2	·405	13·71	·2	·579	19·60
·4	·190	6·44	·4	·281	9·51	·4	·408	13·81	·4	·583	19·74
·6	·192	6·49	·6	·283	9·58	·6	·411	13·91	·6	·587	19·88
·8	·193	6·54	·8	·285	9·66	·8	·414	14·01	·8	·591	20·02
34·0	·195	6·60	44·0	·287	9·73	54·0	·417	14·11	64·0	·595	20·16
·2	·196	6·65	·2	·290	9·80	·2	·420	14·22	·2	·599	20·30
·4	·198	6·70	·4	·292	9·88	·4	·423	14·32	·4	·604	20·44
·6	·199	6·76	·6	·294	9·96	·6	·426	14·43	·6	·608	20·58
·8	·201	6·81	·8	·296	10·03	·8	·429	14·53	·8	·612	20·72

TABLE V.—*continued.*

SATURATION PRESSURE OF WATER VAPOUR.

(*a*) In Inches of Mercury at 32° F. in Latitude 45° at Sea Level; (*b*) in Millibars.

°F.	Inches.	Milli-bars.	°F.	Inches.	Milli-bars.	°F.	Inches.	Milli-bars.	°F.	Inches.	Milli-bars.
65·0	0·616	20·87	75·0	0·866	29·34	85·0	1·201	40·69	95·0	1·645	55·71
·2	·621	21·02	·2	·872	29·54	·2	1·209	40·95	96·0	1·696	57·45
·4	·625	21·17	·4	·878	29·73	·4	1·217	41·22	97·0	1·749	59·23
·6	·629	21·31	·6	·884	29·93	·6	1·225	41·48	98·0	1·803	61·07
·8	·634	21·46	·8	·890	30·13	·8	1·233	41·75	99·0	1·859	62·95
66·0	·638	21·61	76·0	·896	30·33	86·0	1·241	42·01	100·0	1·916	64·89
·2	·642	21·76	·2	·902	30·53	·2	1·248	42·28	101·0	1·975	66·87
·4	·647	21·91	·4	·908	30·73	·4	1·256	42·55	102·0	2·035	68·91
·6	·651	22·06	·6	·914	30·94	·6	1·264	42·82	103·0	2·097	71·00
·8	·656	22·22	·8	·920	31·15	·8	1·273	43·10	104·0	2·160	73·15
67·0	·660	22·37	77·0	·926	31·35	87·0	1·281	43·37	105·0	2·225	75·35
·2	·665	22·52	·2	·932	31·56	·2	1·289	43·65	106·0	2·292	77·61
·4	·670	22·68	·4	·938	31·78	·4	1·297	43·93	107·0	2·360	79·93
·6	·674	22·84	·6	·944	31·99	·6	1·305	44·21	108·0	2·431	82·31
·8	·679	23·00	·8	·951	32·20	·8	1·314	44·49	109·0	2·503	84·75
68·0	·684	23·15	78·0	·957	32·41	88·0	1·322	44·77	110·0	2·577	87·25
·2	·688	23·31	·2	·963	32·62	·2	1·330	45·05	111·0	2·652	89·81
·4	·693	23·47	·4	·970	32·84	·4	1·339	45·34	112·0	2·730	92·44
·6	·698	23·63	·6	·976	33·06	·6	1·347	45·63	113·0	2·810	95·14
·8	·703	23·79	·8	·983	33·27	·8	1·356	45·92	114·0	2·891	97·91
69·0	·707	23·95	79·0	·989	33·49	89·0	1·364	46·20	115·0	2·975	100·74
·2	·712	24·12	·2	·996	33·71	·2	1·373	46·49	116·0	3·061	103·64
·4	·717	24·29	·4	1·002	33·94	·4	1·382	46·79	117·0	3·148	106·62
·6	·722	24·45	·6	1·009	34·16	·6	1·390	47·09	118·0	3·239	109·67
·8	·727	24·62	·8	1·015	34·38	·8	1·399	47·39	119·0	3·331	112·79
70·0	·732	24·79	80·0	1·022	34·60	90·0	1·408	47·68	120·0	3·425	115·99
·2	·737	24·96	·2	1·029	34·83	·2	1·417	47·99			
·4	·742	25·13	·4	1·035	35·06	·4	1·426	48·29			
·6	·747	25·30	·6	1·042	35·29	·6	1·435	48·59			
·8	·752	25·47	·8	1·049	35·52	·8	1·444	48·90			
71·0	·757	25·64	81·0	1·056	35·75	91·0	1·453	49·20			
·2	·762	25·82	·2	1·063	35·99	·2	1·462	49·51			
·4	·768	26·00	·4	1·070	36·23	·4	1·471	49·83			
·6	·773	26·18	·6	1·077	36·46	·6	1·480	50·14			
·8	·778	26·36	·8	1·084	36·70	·8	1·490	50·45			
72·0	·783	26·53	82·0	1·091	36·94	92·0	1·499	50·76			
·2	·789	26·71	·2	1·098	37·18	·2	1·508	51·08			
·4	·794	26·89	·4	1·105	37·42	·4	1·518	51·40			
·6	·799	27·07	·6	1·112	37·66	·6	1·527	51·72			
·8	·805	27·26	·8	1·119	37·91	·8	1·537	52·05			
73·0	·810	27·44	83·0	1·127	38·15	93·0	1·546	52·37			
·2	·816	27·62	·2	1·134	38·40	·2	1·556	52·70			
·4	·821	27·81	·4	1·141	38·65	·4	1·566	53·03			
·6	·827	28·00	·6	1·149	38·90	·6	1·575	53·37			
·8	·832	28·19	·8	1·156	39·15	·8	1·585	53·70			
74·0	·838	28·37	84·0	1·164	39·40	94·0	1·595	54·02			
·2	·843	28·57	·2	1·171	39·65	·2	1·605	54·35			
·4	·849	28·76	·4	1·179	39·91	·4	1·615	54·69			
·6	·855	28·95	·6	1·186	40·17	·6	1·625	55·03			
·8	·861	29·15	·8	1·194	40·43	·8	1·635	55·37			

NOTE.—Since the preceding table was printed the new set of Hygrometric Tables issued by the London Meteorological Office (M.O. 265) has been received. In those tables the values of the saturation vapour pressure obtained by Scheel and Heuse, and published with the authority of the Reichsanstalt in the *Annalen der Physik* in 1910, have been adopted. The following small table gives the amount of the corrections at various temperatures to the values given in Table V. which would be required in order to bring them into agreement with Scheel and Heuse's results.

Temperature °F.	32	50	68	86	104	122
Inches	·000	+·003	+.007	+.013	+·019	+·022
Millibars	+ ·01	+ ·09	+ ·23	+ ·43	+ ·63	+ ·75

TABLE VI.—HUMIDITY.

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.

RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb. 111	112	113	114	115	116	117	118	119	120
89	1·063	1·049	1·036	1·022	1·008	0·995	0·981	0·967	0·954	0·940
	40	*38*	*37*	*35*	*34*	*33*	*31*	*30*	*29*	*27*
88	1·007	0·994	0·980	0·966	0·953	0·939	0·925	0·912	0·898	0·884
	38	*36*	*35*	*33*	*32*	*31*	*29*	*28*	*27*	*26*
87	0·953	0·939	0·925	0·912	0·898	0·884	0·871	0·857	0·843	0·830
	36	*34*	*33*	*32*	*30*	*29*	*28*	*26*	*25*	*24*
86	0·899	0·886	0·872	0·858	0·845	0·831	0·817	0·804	0·790	0·776
	34	*32*	*31*	*30*	*28*	*27*	*26*	*25*	*24*	*23*
85	0·847	0·833	0·820	0·806	0·792	0·779	0·765	0·751	0·738	0·724
	32	*31*	*29*	*28*	*27*	*25*	*24*	*23*	*22*	*21*
84	0·798	0·782	0·768	0·755	0·741	0·727	0·714	0·700	0·686	0·673
	30	*29*	*27*	*26*	*25*	*24*	*23*	*22*	*21*	*20*
83	0·745	0·732	0·718	0·704	0·691	0·677	0·664	0·650	0·636	0·623
	28	*27*	*26*	*24*	*23*	*22*	*21*	*20*	*19*	*18*
82	0·696	0·683	0·669	0·655	0·642	0·628	0·615	0·601	0·587	0·574
	26	*25*	*24*	*23*	*22*	*21*	*20*	*19*	*18*	*17*
81	0·648	0·634	0·621	0·607	0·594	0·580	0·567	0·553	0·539	0·526
	24	*23*	*22*	*21*	*20*	*19*	*18*	*17*	*16*	*15*
80	0·601	0·588	0·574	0·560	0·547	0·533	0·520	0·506	0·492	
	23	*22*	*20*	*19*	*18*	*17*	*16*	*16*	*15*	
79	0·555	0·541	0·528	0·514	0·501	0·487	0·474	0·460		
	21	*20*	*19*	*18*	*17*	*16*	*15*	*14*		
78	0·510	0·496	0·483	0·469	0·456	0·442	0·428			
	19	*18*	*17*	*16*	*15*	*14*	*14*			
77	0·466	0·452	0·438	0·425	0·412	0·398				
	18	*17*	*16*	*15*	*14*	*13*				
76	0·422	0·409	0·395	0·382	0·368					
	16	*15*	*14*	*13*	*12*					
75	0·380	0·366	0·353	0·339						
	14	*13*	*13*	*12*						
74	0·338	0·325	0·311							
	13	*12*	*11*							
73	0·298	0·284								
	11	*10*								
72	0·258									
	10									

TABLE VI—Humidity—*continued.*

Pressure of Water Vapour in Inches of Mercury at 32° F. in Latitude 45°.

Relative Humidity, — per cent.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb.									
	101	102	103	104	105	106	107	108	108	110
89	**1·200**	**1·186**	**1·173**	**1·159**	**1·145**	**1·132**	**1·118**	**1·104**	**1·090**	**1·077**
	61	*58*	*56*	*54*	*51*	*49*	*47*	*45*	*44*	*42*
88	**1·144**	**1·130**	**1·117**	**1·103**	**1·089**	**1·076**	**1·062**	**1·048**	**1·035**	**1·021**
	58	*56*	*53*	*51*	*49*	*47*	*45*	*43*	*41*	*40*
87	**1·089**	**1·076**	**1·062**	**1·048**	**1·035**	**1·021**	**1·007**	**0·994**	**0·980**	**0·966**
	55	*53*	*51*	*49*	*46*	*45*	*42*	*41*	*39*	*37*
86	**1·036**	**1·022**	**1·008**	**0·995**	**0·981**	**0·968**	**0·954**	**0·940**	**0·926**	**0·913**
	52	*50*	*48*	*46*	*44*	*42*	*40*	*39*	*37*	*35*
85	**0·983**	**0·970**	**0·956**	**0·942**	**0·929**	**0·915**	**0·901**	**0·888**	**0·874**	**0·860**
	50	*48*	*46*	*44*	*42*	*40*	*38*	*37*	*35*	*33*
84	**0·932**	**0·918**	**0·905**	**0·891**	**0·877**	**0·864**	**0·850**	**0·836**	**0·823**	**0·809**
	47	*45*	*43*	*41*	*39*	*38*	*36*	*34*	*33*	*31*
83	**0·882**	**0·868**	**0·854**	**0·841**	**0·827**	**0·813**	**0·800**	**0·786**	**0·773**	**0·759**
	45	*43*	*41*	*39*	*37*	*35*	*34*	*32*	*31*	*29*
82	**0·832**	**0·819**	**0·805**	**0·791**	**0·778**	**0·764**	**0·751**	**0·737**	**0·723**	**0·710**
	42	*40*	*38*	*37*	*35*	*33*	*32*	*30*	*29*	*28*
81	**0·784**	**0·770**	**0·757**	**0·743**	**0·730**	**0·716**	**0·702**	**0·689**	**0·675**	**0·662**
	40	*38*	*36*	*34*	*33*	*31*	*30*	*28*	*27*	*26*
80	**0·737**	**0·723**	**0·710**	**0·696**	**0·682**	**0·669**	**0·655**	**0·642**	**0·628**	**0·615**
	37	*36*	*34*	*32*	*31*	*29*	*28*	*26*	*25*	*24*
79	**0·691**	**0·677**	**0·664**	**0·650**	**0·636**	**0·623**	**0·609**	**0·596**	**0·582**	**0·568**
	35	*33*	*32*	*30*	*29*	*27*	*26*	*25*	*23*	*22*
78	**0·645**	**0·632**	**0·618**	**0·605**	**0·591**	**0·578**	**0·564**	**0·550**	**0·537**	**0·523**
	33	*31*	*29*	*28*	*27*	*25*	*24*	*23*	*21*	*20*
77	**0·601**	**0·587**	**0·574**	**0·560**	**0·547**	**0·533**	**0·520**	**0·506**	**0·493**	**0·479**
	30	*29*	*27*	*26*	*25*	*23*	*22*	*21*	*20*	*19*
76	**0·558**	**0·544**	**0·531**	**0·517**	**0·504**	**0·490**	**0·476**	**0·463**	**0·449**	**0·436**
	28	*27*	*25*	*24*	*23*	*21*	*20*	*19*	*18*	*17*
75	**0·515**	**0·502**	**0·488**	**0·475**	**0·461**	**0·447**	**0·434**	**0·420**	**0·407**	**0·394**
	26	*25*	*23*	*22*	*21*	*20*	*18*	*17*	*16*	*15*
74	**0·473**	**0·460**	**0·446**	**0·433**	**0·419**	**0·406**	**0·392**	**0·379**	**0·365**	**0·352**
	24	*23*	*21*	*20*	*19*	*18*	*17*	*16*	*15*	*14*
73	**0·432**	**0·419**	**0·406**	**0·392**	**0·379**	**0·365**	**0·352**	**0·338**	**0·325**	**0·311**
	22	*21*	*19*	*18*	*17*	*16*	*15*	*14*	*13*	*12*
72	**0·393**	**0·379**	**0·366**	**0·352**	**0·339**	**0·325**	**0·312**	**0·298**	**0·285**	**0·271**
	20	*19*	*17*	*16*	*15*	*14*	*13*	*12*	*11*	*10*
71	**0·353**	**0·340**	**0·326**	**0·313**	**0·300**	**0·286**	**0·273**	**0·259**	**0·246**	**0·232**
	18	*17*	*16*	*14*	*13*	*12*	*12*	*11*	*10*	*9*

TABLE VI.—HUMIDITY—*continued.*

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.

RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb.								
	101	102	103	104	105	106	107	108	109
70	**0·315**	**0·302**	**0·288**	**0·275**	**0·261**	**0·248**	**0·234**	**0·221**	**0·208**
	16	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*
69	**0·277**	**0·264**	**0·251**	**0·237**	**0·224**	**0·210**	**0·197**	**0·183**	
	14	*13*	*12*	*11*	*10*	*9*	*8*	*8*	
68	**0·241**	**0·227**	**0·214**	**0·200**	**0·187**	**0·174**	**0·160**		
	12	*11*	*10*	*9*	*8*	*8*	*7*		
67	**0·204**	**0·191**	**0·178**	**0·164**	**0·151**	**0·137**			
	10	*9*	*8*	*8*	*7*	*6*			
66	**0·169**	**0·156**	**0·142**	**0·129**	**0·116**				
	9	*8*	*7*	*6*	*5*				
65	**0·134**	**0·121**	**0·108**	**0·094**					
	7	*6*	*5*	*4*					
64	**0·100**	**0·087**	**0·074**						
	5	*4*	*4*						
63	**0·067**	**0·054**							
	3	*3*							
62	**0·034**								
	2								

TABLE VI.—HUMIDITY—*continued.*

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.
RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb.									
	91	92	93	94	95	96	97	98	99	100
89	1·337	1·323	1·310	1·296	1·282	1·268	1·255	1·241	1·227	1·214
	92	*88*	*85*	*81*	*78*	*75*	*72*	*69*	*66*	*63*
88	1·281	1·267	1·254	1·240	1·226	1·213	1·199	1·185	1·172	1·158
	88	*85*	*81*	*78*	*75*	*71*	*69*	*66*	*63*	*60*
87	1·226	1·212	1·199	1·185	1·171	1·158	1·144	1·130	1·117	1·103
	84	*81*	*78*	*74*	*71*	*68*	*65*	*63*	*60*	*58*
86	1·172	1·159	1·145	1·131	1·118	1·104	1·090	1·077	1·063	1·040
	81	*77*	*74*	*71*	*68*	*65*	*62*	*60*	*57*	*55*
85	1·120	1·106	1·092	1·079	1·065	1·051	1·038	1·024	1·010	0·997
	77	*74*	*71*	*68*	*65*	*62*	*59*	*57*	*54*	*52*
84	1·068	1·054	1·041	1·027	1·014	1·000	0·986	0·973	0·959	0·946
	74	*70*	*67*	*64*	*62*	*59*	*56*	*54*	*52*	*49*
83	1·018	1·004	0·990	0·977	0·963	0·950	0·936	0·922	0·909	0·895
	70	*67*	*64*	*61*	*59*	*56*	*54*	*51*	*49*	*47*
82	0·968	0·955	0·941	0·928	0·914	0·900	0·887	0·873	0·850	0·846
	67	*64*	*61*	*58*	*56*	*53*	*51*	*48*	*46*	*44*
81	0·920	0·906	0·893	0·879	0·866	0·852	0·838	0·825	0·811	0·798
	63	*60*	*58*	*55*	*53*	*50*	*48*	*46*	*44*	*42*
80	0·873	0·859	0·845	0·832	0·818	0·805	0·791	0·778	0·764	0·750
	60	*57*	*55*	*52*	*50*	*47*	*45*	*43*	*41*	*39*
79	0·826	0·813	0·799	0·786	0·772	0·758	0·745	0·731	0·718	0·704
	57	*54*	*52*	*49*	*47*	*45*	*43*	*41*	*39*	*37*
78	0·781	0·767	0·754	0·740	0·727	0·713	0·700	0·686	6·672	0·859
	54	*51*	*49*	*46*	*44*	*42*	*40*	*38*	*36*	*34*
77	0·736	0·723	0·709	0·696	0·682	0·669	0·655	0·642	0·628	0·614
	51	*48*	*46*	*44*	*41*	*39*	*37*	*36*	*34*	*32*
76	0·693	0·679	0·666	0·652	0·639	0·625	0·612	0·598	0·585	0·571
	48	*45*	*43*	*41*	*39*	*37*	*35*	*33*	*31*	*30*
75	0·650	0·637	0·623	0·610	0·596	0·583	0·569	0·556	0·542	0·529
	45	*42*	*40*	*38*	*36*	*34*	*33*	*31*	*29*	*28*
74	0·608	0·595	0·581	0·568	0·554	0·541	0·527	0·514	0·500	0·487
	42	*40*	*38*	*36*	*34*	*32*	*30*	*28*	*27*	*25*
73	0·567	0·554	0·540	0·527	0·514	0·500	0·487	0·473	0·460	0·446
	39	*37*	*35*	*33*	*31*	*29*	*28*	*26*	*25*	*23*
72	0·527	0·514	0·500	0·487	0·474	0·460	0·447	0·433	0·420	0·406
	36	*34*	*32*	*31*	*29*	*27*	*25*	*24*	*23*	*21*
71	0·488	0·475	0·461	0·448	0·434	0·421	0·407	0·394	0·380	0·367
	34	*32*	*30*	*28*	*26*	*25*	*23*	*22*	*20*	*19*

TABLE VI.—HUMIDITY—*continued.*

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.

RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb. 91	92	93	94	95	96	97	98	99	100
70	0·450	0·436	0·423	0·409	0·396	0·382	0·369	0·356	0·342	0·329
	31	*29*	*27*	*26*	*24*	*23*	*21*	*20*	*18*	*17*
69	0·412	0·398	0·385	0·372	0·358	0·345	0·331	0·318	0·304	0·291
	28	*27*	*25*	*23*	*22*	*20*	*19*	*18*	*16*	*15*
68	0·375	0·361	0·348	0·335	0·321	0·308	0·294	0·281	0·268	0·254
	26	*24*	*22*	*21*	*20*	*18*	*17*	*16*	*14*	*13*
67	0·339	0·325	0·312	0·298	0·285	0·272	0·258	0·245	0·231	0·218
	23	*22*	*20*	*19*	*17*	*16*	*15*	*14*	*12*	*11*
66	0·303	0·290	0·276	0·263	0·250	0·236	0·223	0·209	0·196	0·182
	21	*19*	*18*	*16*	*15*	*14*	*13*	*12*	*11*	*10*
65	0·268	0·255	0·242	0·228	0·215	0·201	0·188	0·175	0·161	0·148
	18	*17*	*16*	*14*	*13*	*12*	*11*	*10*	*9*	*8*
64	0·234	0·221	0·207	0·194	0·181	0·167	0·154	0·141	0·127	0·114
	16	*15*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*
63	0·201	0·187	0·174	0·161	0·147	0·134	0·121	0·107	0·094	0·080
	14	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*
62	0·168	0·154	0·141	0·128	0·114	0·101	0·088	0·074	0·061	0·048
	12	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*
61	0·136	0·122	0·109	0·096	0·082	0·069	0·056	0·042	0·029	0·016
	9	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*2*	*1*
60	0·104	0·091	0·077	0·064	0·051	0·037	0·024	0·011		
	7	*6*	*5*	*4*	*3*	*2*	*1*	*1*		
59	0·073	0·060	0·046	0·033	0·020	0·006				
	5	*4*	*3*	*2*	*1*					
58	0·043	0·029	0·016	0·003						
	3	*2*	*1*							
57	0·013									
	1									

TABLE VI.—Humidity—*continued.*

Pressure of Water Vapour in Inches of Mercury at 32° F. in Latitude 45°.

Relative Humidity, — per cent.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb. 80	81	82	83	84	85	86	87	88	89	90
89	..	..	..	..	..	..	..	..	..	**1·364** *100*	**1·351** *96*
88			..	..	..	..		..	**1·322** *100*	**1·308** *96*	**1·295** *92*
87	..		..	..	..	..		**1·281** *100*	**1·267** *96*	**1·253** *92*	**1·240** *88*
86			..	..	..		**1·240** *100*	**1·227** *96*	**1·213** *92*	**1·200** *88*	**1·186** *84*
85	..		..	..	..	**1·202** *100*	**1·188** *96*	**1·174** *92*	**1·161** *88*	**1·147** *84*	**1·133** *80*
84	..		..	..	**1·164** *100*	**1·150** *96*	**1·136** *92*	**1·123** *88*	**1·109** *84*	**1·095** *80*	**1·082** *77*
83	..			**1·127** *100*	**1·113** *96*	**1·099** *91*	**1·086** *88*	**1·072** *84*	**1·058** *80*	**1·045** *77*	**1·031** *73*
82	..		**1·091** *100*	**1·077** *96*	**1·064** *91*	**1·050** *87*	**1·036** *84*	**1·023** *80*	**1·009** *76*	**0·996** *73*	**0·982** *70*
81	..	**1·056** *100*	**1·042** *96*	**1·029** *91*	**1·015** *87*	**1·001** *83*	**0·988** *80*	**0·974** *76*	**0·961** *73*	**0·947** *69*	**0·934** *66*
80	**1·022** *100*	**1·008** *95*	**0·995** *91*	**0·981** *87*	**0·968** *83*	**0·954** *79*	**0·940** *76*	**0·927** *72*	**0·913** *69*	**0·900** *66*	**0·886** *63*
79	**0·975** *95*	**0·962** *91*	**0·948** *87*	**0·935** *83*	**0·921** *79*	**0·908** *76*	**0·894** *72*	**0·880** *69*	**0·867** *66*	**0·853** *63*	**0·840** *60*
78	**0·930** *91*	**0·916** *87*	**0·903** *83*	**0·889** *79*	**0·876** *75*	**0·862** *72*	**0·849** *68*	**0·835** *65*	**0·822** *62*	**0·808** *59*	**0·794** *56*
77	**0·885** *87*	**0·872** *83*	**0·858** *79*	**0·845** *75*	**0·831** *71*	**0·818** *68*	**0·804** *65*	**0·790** *62*	**0·777** *59*	**0·763** *56*	**0·750** *53*
76	**0·842** *82*	**0·828** *78*	**0·815** *75*	**0·801** *71*	**0·788** *68*	**0·774** *64*	**0·760** *61*	**0·747** *58*	**0·733** *55*	**0·720** *53*	**0·706** *50*
75	**0·799** *78*	**0·785** *74*	**0·772** *71*	**0·758** *67*	**0·745** *64*	**0·731** *61*	**0·718** *58*	**0·704** *55*	**0·691** *52*	**0·677** *50*	**0·664** *47*
74	**0·757** *74*	**0·743** *70*	**0·730** *67*	**0·716** *64*	**0·703** *60*	**0·689** *57*	**0·676** *54*	**0·662** *52*	**0·649** *49*	**0·635** *47*	**0·622** *44*
73	**0·716** *70*	**0·702** *67*	**0·689** *63*	**0·675** *60*	**0·662** *57*	**0·648** *54*	**0·635** *51*	**0·621** *49*	**0·608** *46*	**0·594** *44*	**0·581** *41*
72	**0·676** *66*	**0·662** *63*	**0·649** *59*	**0·635** *56*	**0·622** *53*	**0·608** *51*	**0·595** *48*	**0·581** *45*	**0·568** *43*	**0·554** *41*	**0·541** *38*
71	**0·636** *62*	**0·623** *59*	**0·609** *56*	**0·596** *53*	**0·582** *50*	**0·569** *47*	**0·555** *45*	**0·542** *42*	**0·528** *40*	**0·515** *38*	**0·502** *36*

TABLE VI.—Humidity—*continued.*

Pressure of Water Vapour in Inches of Mercury at 32° F. in Latitude 45°.

Relative Humidity, — per cent.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb.										
	80	81	82	83	84	85	86	87	88	89	90
70	**0·598**	**0·584**	**0·571**	**0·557**	**0·544**	**0·530**	**0·517**	**0·503**	**0·490**	**0·476**	**0·463**
	58	*55*	*52*	*49*	*47*	*44*	*42*	*39*	*37*	*35*	*33*
69	**0·560**	**0·546**	**0·533**	**0·519**	**0·506**	**0·492**	**0·479**	**0·466**	**0·452**	**0·439**	**0·425**
	55	*52*	*49*	*46*	*43*	*41*	*39*	*36*	*34*	*32*	*30*
68	**0·522**	**0·509**	**0·496**	**0·482**	**0·469**	**0·455**	**0·442**	**0·428**	**0·415**	**0·402**	**0·388**
	51	*48*	*45*	*43*	*40*	*38*	*36*	*33*	*31*	*29*	*28*
67	**0·486**	**0·473**	**0·459**	**0·446**	**0·432**	**0·419**	**0·406**	**0·392**	**0·379**	**0·365**	**0·352**
	48	*45*	*42*	*40*	*37*	*35*	*33*	*31*	*29*	*27*	*25*
66	**0·450**	**0·437**	**0·424**	**0·410**	**0·397**	**0·384**	**0·370**	**0·357**	**0·343**	**0·330**	**0·316**
	44	*41*	*39*	*36*	*34*	*32*	*30*	*28*	*26*	*24*	*22*
65	**0·416**	**0·402**	**0·389**	**0·375**	**0·362**	**0·349**	**0·335**	**0·322**	**0·308**	**0·295**	**0·282**
	41	*38*	*36*	*33*	*31*	*29*	*27*	*25*	*23*	*22*	*20*
64	**0·381**	**0·368**	**0·354**	**0·341**	**0·328**	**0·314**	**0·301**	**0·288**	**0·274**	**0·261**	**0·248**
	37	*35*	*32*	*30*	*28*	*26*	*24*	*22*	*21*	*19*	*18*
63	**0·348**	**0·334**	**0·321**	**0·308**	**0·294**	**0·281**	**0·268**	**0·254**	**0·241**	**0·227**	**0·214**
	34	*32*	*29*	*27*	*25*	*23*	*22*	*20*	*18*	*17*	*15*
62	**0·315**	**0·301**	**0·288**	**0·275**	**0·261**	**0·248**	**0·234**	**0·221**	**0·208**	**0·194**	**0·181**
	31	*29*	*26*	*24*	*22*	*21*	*19*	*17*	*16*	*14*	*13*
61	**0·282**	**0·269**	**0·256**	**0·242**	**0·229**	**0·216**	**0·202**	**0·189**	**0·176**	**0·162**	**0·149**
	28	*25*	*23*	*22*	*20*	*18*	*16*	*15*	*13*	*12*	*11*
60	**0·250**	**0·237**	**0·224**	**0·210**	**0·197**	**0·184**	**0·171**	**0·157**	**0·144**	**0·131**	**0·117**
	25	*22*	*21*	*19*	*17*	*15*	*14*	*12*	*11*	*10*	*8*
59	**0·219**	**0·206**	**0·193**	**0·180**	**0·166**	**0·153**	**0·140**	**0·126**	**0·113**	**0·100**	**0·086**
	21	*20*	*18*	*16*	*14*	*13*	*11*	*10*	*9*	*7*	*6*
58	**0·189**	**0·176**	**0·162**	**0·149**	**0·136**	**0·122**	**0·109**	**0·096**	**0·083**	**0·069**	**0·056**
	18	*17*	*15*	*13*	*12*	*10*	*9*	*7*	*6*	*5*	*4*
57	**0·159**	**0·146**	**0·132**	**0·119**	**0·106**	**0·092**	**0·079**	**0·066**	**0·053**	**0·039**	**0·026**
	16	*14*	*12*	*11*	*9*	*8*	*6*	*5*	*4*	*3*	*2*
56	**0·130**	**0·116**	**0·103**	**0·090**	**0·076**	**0·063**	**0·050**	**0·037**	**0·023**	**0·010**	..
	13	*11*	*9*	*8*	*7*	*5*	*4*	*3*	*2*	*1*	
55	**0·101**	**0·087**	**0·074**	**0·061**	**0·048**	**0·034**	**0·021**	**0·008**	..	..	
	10	*8*	*7*	*5*	*4*	*3*	*2*	*1*			
54	**0·072**	**0·059**	**0·046**	**0·033**	**0·019**	**0·006**	..	..	..	..	
	7	*6*	*4*	*3*	*2*	*1*					
53	**0·044**	**0·031**	**0·018**	**0·005**	..	..	..	..	..	..	
	4	*3*	*2*								
52	**0·017**	**0·004**	..	..	..			..	..	..	
	2										

TABLE VI.—Humidity—*continued.*

Pressure of Water Vapour in Inches of Mercury at 32° F. in Latitude 45°.

Relative Humidity, — per cent.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb. 69	70	71	72	73	74	75	76	77	78	79
79	..	..		..	..	..			..	..	0·989 *100*
78	..		..	..	..	..		..	..	0·957 *100*	0·943 *95*
77	..	..	..	..	..	..	..	..	0·926 *100*	0·912 *95*	0·899 *91*
76	..	..	..	..	..	..	..	0·896 *100*	0·882 *95*	0·869 *91*	0·855 *86*
75	..	..	..	..	..	..	0·868 *100*	0·853 *95*	0·839 *91*	0·826 *86*	0·812 *82*
74	..	..		..	..	0·838 *100*	0·824 *95*	0·811 *90*	0·797 *86*	0·784 *82*	0·770 *78*
73	..	..		..	0·810 *100*	0·797 *95*	0·783 *90*	0·770 *86*	0·756 *82*	0·743 *78*	0·729 *74*
72	..	..	..	0·783 *100*	0·770 *95*	0·756 *90*	0·743 *86*	0·730 *81*	0·716 *77*	0·703 *73*	0·689 *70*
71	..	..	0·757 *100*	0·744 *95*	0·730 *90*	0·717 *86*	0·704 *81*	0·690 *77*	0·676 *73*	0·663 *69*	0·650 *66*
70	..	0·732 *100*	0·719 *95*	0·705 *90*	0·692 *85*	0·678 *81*	0·665 *77*	0·651 *73*	0·638 *69*	0·624 *65*	0·611 *62*
69	0·707 *100*	0·694 *95*	0·680 *90*	0·667 *85*	0·654 *81*	0·640 *76*	0·627 *72*	0·613 *68*	0·600 *65*	0·586 *61*	0·573 *58*
68	0·670 *95*	0·657 *90*	0·643 *85*	0·630 *80*	0·616 *76*	0·603 *72*	0·590 *68*	0·576 *64*	0·563 *61*	0·549 *57*	0·536 *54*
67	0·634 *90*	0·620 *85*	0·607 *80*	0·593 *76*	0·580 *72*	0·567 *68*	0·553 *64*	0·540 *60*	0·526 *57*	0·513 *54*	0·500 *51*
66	0·598 *85*	0·584 *80*	0·571 *75*	0·558 *71*	0·544 *67*	0·531 *63*	0·518 *60*	0·504 *56*	0·491 *53*	0·477 *50*	0·464 *47*
65	0·563 *80*	0·549 *75*	0·536 *71*	0·523 *67*	0·509 *63*	0·496 *59*	0·482 *56*	0·469 *52*	0·456 *49*	0·442 *46*	0·429 *43*
64	0·528 *75*	0·515 *70*	0·502 *66*	0·488 *62*	0·475 *59*	0·462 *55*	0·448 *52*	0·435 *49*	0·421 *46*	0·408 *43*	0·395 *40*
63	0·495 *70*	0·481 *66*	0·468 *62*	0·455 *58*	0·441 *54*	0·428 *51*	0·414 *48*	0·401 *45*	0·388 *42*	0·374 *39*	0·361 *36*
62	0·462 *65*	0·448 *61*	0·435 *57*	0·421 *54*	0·408 *50*	0·395 *47*	0·381 *44*	0·368 *41*	0·355 *38*	0·341 *36*	0·328 *33*
61	0·429 *61*	0·416 *57*	0·402 *53*	0·389 *50*	0·376 *46*	0·362 *43*	0·349 *40*	0·336 *37*	0·322 *35*	0·309 *32*	0·296 *30*

TABLE VI.—Humidity—*continued.*

Pressure of Water Vapour in Inches of Mercury at 32° F. in Latitude 45°.

Relative Humidity, — per cent.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb. 69	70	71	72	73	74	75	76	77	78	79
60	0·397	0·384	0·370	0·357	0·344	0·330	0·317	0·304	0·290	0·277	0·264
	56	*52*	*49*	*46*	*42*	*39*	*37*	*34*	*31*	*29*	*27*
59	0·366	0·353	0·339	0·326	0·313	0·299	0·286	0·273	0·259	0·246	0·233
	52	*48*	*45*	*42*	*39*	*36*	*33*	*30*	*28*	*26*	*24*
58	0·335	0·322	0·309	0·295	0·282	0·269	0·255	0·242	0·229	0·216	0·202
	47	*44*	*41*	*38*	*35*	*32*	*29*	*27*	*25*	*23*	*20*
57	0·305	0·292	0·278	0·265	0·252	0·239	0·225	0·212	0·199	0·186	0·172
	43	*40*	*37*	*34*	*31*	*28*	*26*	*24*	*21*	*19*	*17*
56	0·276	0·262	0·249	0·236	0·222	0·209	0·196	0·183	0·169	0·156	0·143
	39	*36*	*33*	*30*	*27*	*25*	*23*	*20*	*18*	*16*	*14*
55	0·247	0·233	0·220	0·207	0·194	0·180	0·167	0·154	0·140	0·127	0·114
	35	*32*	*29*	*26*	*24*	*22*	*19*	*17*	*15*	*13*	*12*
54	0·218	0·205	0·192	0·178	0·165	0·152	0·139	0·125	0·112	0·099	0·086
	31	*28*	*25*	*23*	*20*	*18*	*16*	*14*	*12*	*10*	*9*
53	0·190	0·177	0·164	0·150	0·137	0·124	0·111	0·097	0·084	0·071	0·058
	27	*24*	*22*	*19*	*17*	*15*	*13*	*11*	*9*	*7*	*6*
52	0·163	0·149	0·136	0·123	0·110	0·096	0·083	0·070	0·057	0·044	0·030
	23	*20*	*18*	*16*	*14*	*12*	*10*	*8*	*6*	*5*	*3*
51	0·136	0·122	0·109	0·096	0·083	0·070	0·056	0·043	0·030	0·017	0·004
	19	*17*	*14*	*12*	*10*	*8*	*6*	*5*	*3*	*2*	..
50	0·109	0·096	0·083	0·069	0·056	0·043	0·030	0·017	0·003	..	..
	15	*13*	*11*	*9*	*7*	*5*	*3*	*2*			
49	0·083	0·070	0·056	0·043	0·030	0·017	0·004	..	..	..	
	12	*9*	*7*	*6*	*4*	*2*					
48	0·057	0·044	0·031	0·018	0·005	..			..	..	
	8	*6*	*4*	*2*	*1*						
47	0·032	0·019	0·006	..	..	..			..	..	
	5	*3*	*1*								
46	0·007	..	..	..	..	..	..		..	..	
	1										

TABLE VI.—HUMIDITY—*continued.*

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.
RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb										
	58	59	60	61	62	63	64	65	66	67	68
68	..	..			..	..	..	..		..	0·684 *100*
67	..	..			..	..	..	..		0·660 *100*	0·647 *95*
66	..	..	..		..	..	..	..	0·638 *100*	0·625 *95*	0·611 *89*
65	..	..			..	..	..	0·616 *100*	0·603 *94*	0·590 *89*	0·576 *84*
64	..	..	..		..	..	0·595 *100*	0·582 *94*	0·569 *89*	0·555 *84*	0·542 *79*
63	..	..	..		..	0·575 *100*	0·561 *94*	0·548 *89*	0·535 *84*	0·521 *79*	0·508 *74*
62	..				0·555 *100*	0·542 *94*	0·528 *89*	0·515 *84*	0·502 *79*	0·488 *74*	0·475 *69*
61	..	..	..	0·536 *100*	0·522 *94*	0·509 *89*	0·496 *83*	0·482 *78*	0·469 *73*	0·456 *69*	0·442 *65*
60	..	..	0·517 *100*	0·504 *94*	0·490 *88*	0·477 *83*	0·464 *78*	0·450 *73*	0·437 *68*	0·424 *64*	0·410 *60*
59	..	0·499 *100*	0·486 *94*	0·472 *88*	0·459 *83*	0·446 *78*	0·432 *73*	0·419 *68*	0·406 *64*	0·392 *59*	0·379 *55*
58	0·482 *100*	0·468 *94*	0·455 *88*	0·442 *82*	0·428 *77*	0·415 *72*	0·402 *67*	0·388 *63*	0·375 *59*	0·362 *55*	0·348 *51*
57	0·451 *94*	0·438 *88*	0·425 *82*	0·411 *77*	0·398 *72*	0·385 *67*	0·372 *62*	0·358 *58*	0·345 *54*	0·332 *50*	0·318 *47*
56	0·422 *88*	0·408 *82*	0·395 *76*	0·382 *71*	0·368 *66*	0·355 *62*	0·342 *57*	0·329 *53*	0·315 *49*	0·302 *46*	0·289 *42*
55	0·392 *81*	0·379 *76*	0·366 *71*	0·353 *66*	0·339 *61*	0·326 *57*	0·313 *53*	0·300 *49*	0·286 *45*	0·273 *41*	0·260 *38*
54	0·364 *76*	0·351 *70*	0·337 *65*	0·324 *61*	0·311 *56*	0·298 *52*	0·284 *48*	0·271 *44*	0·258 *40*	0·245 *37*	0·231 *34*
53	0·336 *70*	0·322 *65*	0·309 *60*	0·296 *55*	0·283 *51*	0·269 *47*	0·256 *43*	0·243 *39*	0·230 *36*	0·217 *33*	0·203 *30*
52	0·308 *64*	0·295 *59*	0·282 *54*	0·268 *50*	0·255 *46*	0·242 *42*	0·229 *38*	0·216 *35*	0·202 *32*	0·189 *29*	0·176 *26*
51	0·281 *58*	0·268 *54*	0·254 *49*	0·241 *45*	0·228 *41*	0·215 *37*	0·202 *34*	0·188 *31*	0·175 *27*	0·162 *25*	0·149 *22*
50	0·254 *53*	0·241 *48*	0·228 *44*	0·215 *40*	0·201 *36*	0·188 *33*	0·175 *29*	0·162 *26*	0·149 *23*	0·135 *20*	0·122 *18*

TABLE VI.—HUMIDITY—*continued.*

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.
RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb.										
	58	59	60	61	62	63	64	65	66	67	68
49	**0·228**	**0·215**	**0·202**	**0·188**	**0·175**	**0·162**	**0·149**	**0·136**	**0·122**	**0·109**	**0·096**
	47	*43*	*39*	*35*	*32*	*28*	*25*	*22*	*19*	*17*	*14*
48	**0·202**	**0·189**	**0·176**	**0·163**	**0·150**	**0·136**	**0·123**	**0·110**	**0·097**	**0·084**	**0·071**
	42	*38*	*34*	*30*	*27*	*24*	*21*	*18*	*15*	*13*	*10*
47	**0·177**	**0·164**	**0·151**	**0·138**	**0·124**	**0·111**	**0·098**	**0·085**	**0·072**	**0·058**	**0·045**
	37	*33*	*29*	*26*	*22*	*19*	*16*	*14*	*11*	*9*	*7*
46	**0·152**	**0·139**	**0·126**	**0·113**	**0·100**	**0·086**	**0·073**	**0·060**	**0·047**	**0·034**	**0·021**
	32	*28*	*24*	*21*	*18*	*15*	*12*	*10*	*7*	*5*	*3*
45	**0·128**	**0·114**	**0·101**	**0·088**	**0·075**	**0·062**	**0·049**	**0·036**	**0·022**	**0·009**	
	26	*23*	*20*	*16*	*14*	*11*	*8*	*6*	*3*	*1*	
44	**0·104**	**0·090**	**0·077**	**0·064**	**0·051**	**0·038**	**0·025**	**0·012**	..	..	
	21	*18*	*15*	*12*	*9*	*7*	*4*	*2*			
43	**0·080**	**0·067**	**0·054**	**0·040**	**0·027**	**0·014**	**0·001**	..		..	..
	17	*13*	*10*	*8*	*5*	*2*					
42	**0·056**	**0·043**	**0·030**	**0·017**	**0·004**	..	..			..	..
	12	*9*	*6*	*3*	*1*						
41	**0·034**	**0·020**	**0·008**	..	..	..	..			..	
	7	*4*	*1*								
40	**0·011**	..	..	..	..	..	..	..	..	..	..
	2										

Wet Bulb.	Dry Bulb.										
	47	48	49	50	51	52	53	54	55	56	57
57	..	..	..	..	..	..	..	..	..	..	**0·464**
											100
56	..	..	..		..	..	..	..	..	**0·448**	**0·435**
									..	*100*	*94*
55	..	..	..		..	..	..	..	**0·432**	**0·419**	**0·406**
									100	*93*	*87*
54	..	..	..		..	..	..	**0·417**	**0·404**	**0·390**	**0·377**
								100	*93*	*87*	*81*
53	..	..	..		..	..	**0·402**	**0·389**	**0·375**	**0·362**	**0·349**
							100	*93*	*87*	*81*	*75*
52	..	..	..		..	**0·387**	**0·374**	**0·361**	**0·348**	**0·334**	**0·321**
						100	*93*	*87*	*80*	*75*	*69*
51	..	..	..	..	**0·373**	**0·360**	**0·347**	**0·334**	**0·321**	**0·307**	**0·294**
					100	*93*	*86*	*80*	*74*	*69*	*63*

TABLE VI.—HUMIDITY—*continued.*

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.

RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29· 7 Inches.

Wet Bulb.	Dry Bulb.										
	47	48	49	50	51	52	53	54	55	56	57
50	..	..	..	0·360	0·347	0·333	0·320	0·307	0·294	0·281	0·267
				100	*93*	*86*	*80*	*74*	*68*	*63*	*58*
49	..	..	0·347	0·334	0·320	0·307	0·294	0·281	0·268	0·254	0·241
			100	*93*	*86*	*79*	*73*	*67*	*62*	*57*	*52*
48	..	0·334	0·321	0·308	0·295	0·281	0·268	0·255	0·242	0·229	0·216
		100	*93*	*86*	*79*	*73*	*67*	*61*	*56*	*51*	*46*
47	0·322	0·309	0·296	0·282	0·269	0·256	0·243	0·230	0·217	0·203	0·190
	100	*92*	*85*	*78*	*72*	*66*	*60*	*55*	*50*	*45*	*41*
46	0·297	0·284	0·270	0·257	0·244	0·231	0·218	0·205	0·192	0·178	0·165
	92	*85*	*78*	*72*	*65*	*60*	*54*	*49*	*44*	*40*	*36*
45	0·272	0·259	0·246	0·233	0·220	0·206	0·193	0·180	0·167	0·154	0·141
	85	*78*	*71*	*65*	*59*	*53*	*48*	*43*	*39*	*34*	*30*
44	0·248	0·235	0·222	0·209	0·196	0·182	0·169	0·156	0·143	0·130	0·117
	77	*70*	*64*	*58*	*52*	*47*	*42*	*37*	*33*	*29*	*25*
43	0·224	0·211	0·198	0·185	0·172	0·159	0·145	0·132	0·119	0·106	0·093
	70	*63*	*57*	*51*	*46*	*41*	*36*	*32*	*28*	*24*	*20*
42	0·201	0·188	0·174	0·161	0·148	0·135	0·122	0·109	0·096	0·083	0·070
	62	*56*	*50*	*45*	*40*	*35*	*30*	*26*	*22*	*18*	*15*
41	0·178	0·165	0·152	0·138	0·125	0·112	0·099	0·086	0·073	0·060	0·047
	55	*49*	*44*	*38*	*34*	*29*	*25*	*21*	*17*	*13*	*10*
40	0·155	0·142	0·129	0·116	0·103	0·090	0·076	0·063	0·050	0·037	0·024
	48	*42*	*37*	*32*	*27*	*23*	*19*	*15*	*12*	*8*	*5*
39	0·133	0·120	0·106	0·093	0·080	0·067	0·054	0·041	0·028	0·015	0·002
	41	*36*	*31*	*26*	*22*	*17*	*13*	*10*	*6*	*3*	
38	0·111	0·098	0·084	0·071	0·058	0·045	0·032	0·019	0·006	..	..
	34	*29*	*24*	*20*	*16*	*12*	*8*	*5*	*1*		
37	0·089	0·076	0·063	0·050	0·037	0·024	0·011	..	..		
	28	*23*	*18*	*14*	*10*	*6*	*3*				
36	0·068	0·054	0·042	0·028	0·015	0·002	..	..			
	21	*16*	*12*	*8*	*4*	*1*					
35	0·046	0·033	0·020	0·007	..	..	..	..	..	..	
	14	*10*	*6*	*2*							
34	0·026	0·013	..	..		..	..	..			
	8	*4*									
33	0·005	..	..		..	..	..	..	..	..	
	2										

TABLE VI.—HUMIDITY—*continued*.

PRESSURE OF WATER VAPOUR IN INCHES OF MERCURY AT 32° F. IN LATITUDE 45°.
RELATIVE HUMIDITY, — PER CENT.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb. 36	37	38	39	40	41	42	43	44	45	46
46	..	..	..	..	..		..	..	..		0·310 100
45	..	..	..	..			..	..	..	0·298 100	0·285 92
44	..	..	..	..			..	..	0·287 100	0·274 92	0·261 84
43	..	..	..	..			..	0·277 100	0·264 92	0·250 84	0·237 77
42	..	..	..	..			0·266 100	0·253 91	0·240 84	0·227 76	0·214 69
41	..	..	..	..		0·256 100	0·243 91	0·230 83	0·217 75	0·204 68	0·191 62
40	..	..	..	..	0·246 100	0·233 91	0·220 83	0·207 75	0·194 68	0·181 61	0·168 54
39	..	..	..	0·237 100	0·224 91	0·211 82	0·198 74	0·185 67	0·172 60	0·159 53	0·146 47
38	..	..	0·228 100	0·215 91	0·202 82	0·189 74	0·176 66	0·163 59	0·150 52	0·137 46	0·124 40
37	..	0·219 100	0·206 90	0·193 81	0·180 73	0·167 65	0·154 58	0·141 51	0·128 45	0·115 38	0·102 33
36	0·211 100	0·198 90	0·185 81	0·172 72	0·159 64	0·146 57	0·133 50	0·120 43	0·107 37	0·094 31	0·081 26
35	0·190 90	0·177 81	0·164 72	0·151 64	0·138 56	0·125 49	0·112 42	0·098 36	0·086 30	0·072 24	0·060 19
34	0·169 80	0·156 71	0·143 63	0·130 55	0·117 47	0·104 40	0·091 34	0·078 28	0·065 23	0·052 17	0·039 12
33	0·148 70	0·135 62	0·122 54	0·109 46	0·096 39	0·083 33	0·070 27	0·057 21	0·044 15	0·031 10	0·018 6
32	0·130 62	0·118 54	0·106 46	0·093 39	0·081 33	0·068 27	0·056 21	0·044 16	0·031 11	0·019 6	0·006 2
31	0·114 54	0·102 46	0·090 39	0·079 33	0·067 27	0·055 21	0·043 16	0·031 11	0·020 6	0·008 2	.. ..
30	0·095 45	0·084 38	0·072 31	0·060 25	0·048 20	0·036 14	0·025 9	0·013 5	0·001		
29	0·077 37	0·065 30	0·054 23	0·042 18	0·030 12	0·018 7	0·006 2	..	..		
28	0·059 28	0·047 21	0·035 16	0·024 10	0·012 5	..	..	..	..		
27	0·041 19	0·029 13	0·018 8	0·006 2	..		..	..	..	..	..
26	0·024 11	0·012 5	..	..	..		..	..	..	..	..
25	0·006 3	..	..	..	..		..	..	..	..	..

TABLE VI.—Humidity—*continued.*

Pressure of Water Vapour in Inches of Mercury at 32° F. in Latitude 45°.

Relative Humidity, — per cent.

Barometer Reading, 29·7 Inches.

Wet Bulb.	Dry Bulb. 25	26	27	28	29	30	31	32	33	34	35
35	..	..	..	..	..	..		..	..	..	**0·203**
											100
34			..	..	..	..	..	..	..	**0·195**	**0·182**
										100	*90*
33	..		..	..	..			..	**0·187**	**0·174**	**0·161**
									100	*89*	*80*
32			..	..	..	..		**0·180**	**0·168**	**0·155**	**0·143**
								100	*89*	*80*	*70*
31			..	..	..	..	**0·173**	**0·161**	**0·149**	**0·137**	**0·126**
							100	*89*	*80*	*70*	*62*
30			..	..	..	**0·166**	**0·154**	**0·142**	**0·131**	**0·119**	**0·107**
						100	*89*	*79*	*70*	*61*	*53*
29			..	..	**0·159**	**0·148**	**0·136**	**0·124**	**0·112**	**0·100**	**0·089**
					100	*89*	*79*	*69*	*60*	*52*	*44*
28			..	**0·153**	**0·141**	**0·130**	**0·118**	**0·106**	**0·094**	**0·082**	**0·071**
				100	*89*	*78*	*68*	*59*	*50*	*42*	*35*
27		..	**0·147**	**0·135**	**0·123**	**0·112**	**0·100**	**0·088**	**0·076**	**0·065**	**0·053**
			100	*88*	*77*	*67*	*58*	*49*	*41*	*33*	*26*
26		**0·141**	**0·129**	**0·117**	**0·106**	**0·094**	**0·082**	**0·070**	**0·059**	**0·047**	**0·035**
		100	*88*	*77*	*66*	*57*	*48*	*39*	*31*	*24*	*17*
25	**0·135**	**0·124**	**0·112**	**0·100**	**0·088**	**0·077**	**0·065**	**0·053**	**0·041**	**0·030**	**0·018**
	100	*88*	*76*	*65*	*55*	*46*	*37*	*30*	*22*	*15*	*9*
24	**0·118**	**0·106**	**0·094**	**0·083**	**0·071**	**0·059**	**0·048**	**0·036**	**0·024**	**0·012**	**0·001**
	87	*75*	*64*	*54*	*45*	*36*	*28*	*20*	*13*	*6*	..
23	**0·101**	**0·089**	**0·078**	**0·066**	**0·054**	**0·042**	**0·031**	**0·019**	**0·007**	..	..
	75	*63*	*53*	*43*	*34*	*26*	*18*	*11*	*4*	..	..
22	**0·084**	**0·072**	**0·061**	**0·049**	**0·037**	**0·026**	**0·014**	**0·002**	..	..	..
	62	*51*	*41*	*32*	*23*	*15*	*8*	*1*			
21	**0·068**	**0·056**	**0·044**	**0·032**	**0·021**	**0·009**	..	..	..	..	
	50	*40*	*30*	*21*	*13*	*5*					
20	**0·051**	**0·040**	**0·028**	**0·016**	**0·004**	..		..	..	..	..
	38	*28*	*19*	*11*	*3*						
19	**0·035**	**0·023**	**0·012**	..	..			..	..	..	
	26	*17*	*8*								
18	**0·019**	**0·007**	..	..	..			..	..	..	
	14	*5*									
17	**0·003**	..	..	..	..	..	..	..	..	..	
	2										

TABLE VI (*a*).

CORRECTION TO VAPOUR PRESSURES GIVEN IN TABLE VI. FOR DIFFERENCES OF BAROMETER READING AT STATION LEVEL FROM 29·7 INCHES.

Pressure Difference.	Depression of Wet Bulb below Dry Bulb °F.					
	5	10	15	20	25	30
Inches	in.	in.	in.	in.	in.	in.
1	•002	•004	•007	•009	•011	•013
2	•005	•009	•014	•018	•022	•027
3	•007	•013	•020	•026	•033	•040
4	•009	•018	•026	•035	•044	•053
5	•011	•022	•033	•044	•055	•066

Corrections are additive if the pressure is below 29·7 inches substractive if it is above.

TABLE VI (*b*).

EQUIVALENT IN VAPOUR PRESSURE OF 1 % RELATIVE HUMIDITY.

Dry Bulb.	Vapour Pressure.
°F.	in.
50	•004
60	•005
70	•007
80	•010
90	•014
100	•019
110	•025

TABLE VII (*a*).

TEMPERATURE CORRECTION TO BAROMETERS OF THE FORTIN PATTERN.

Applicable to Readings of Mercury Barometers of the Fortin Pattern, with Brass Scales extending from the Cistern to the top of the Mercury Column and reducing them to 32° F.

Attached Ther.	Barometer Reading.—Inches.											Att. Ther.
	26•0	26•5	27•0	27•5	28•0	28•5	29•0	29•5	30•0	30•5	31•0	
°F.												°F.
35	•015	•015	•016	•016	•016	•017	•017	•017	•017	•018	•018	35
36	•017	•018	•018	•018	•019	•019	•019	•020	•020	•020	•021	36
37	•020	•020	•021	•021	•021	•022	•022	•022	•023	•023	•024	37
38	•022	•023	•023	•023	024	•024	•025	•025	•026	•026	•026	38
39	•024	•025	•025	•026	•026	•027	•027	•028	•028	•029	•029	39
40	•027	•027	•028	•028	•029	•030	•030	•031	•031	•032	•032	40
41	•029	•030	•030	•031	•031	•032	•033	•033	•034	•034	•035	41
42	•032	•032	•033	•033	•034	•035	•035	•036	•036	•037	•038	42
43	•034	•035	•035	•036	•036	•037	•038	•038	•039	•040	•040	43
44	•036	•037	•038	•038	•039	•040	•040	•041	•042	•043	•043	44
45	•039	•039	•040	•041	•042	•042	•043	•044	•045	•045	•046	45
46	•041	•042	•043	•043	•044	•045	•046	•047	•047	•048	•049	46
47	•043	•044	•045	•046	•047	•048	•048	•049	•050	•051	•052	47
48	•046	•047	•047	•048	•049	•050	•051	•052	•053	•054	•054	48
49	•048	•049	•050	•051	•052	•053	•054	•055	•055	•056	•057	49

NOTE.—The correction is to be subtracted in every case.

TABLE VII (*a*).—*continued.*

Attached Ther.	Barometer Reading.—Inches.											Att. Ther.
	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
°F.												°F.
50	·050	·051	·052	·053	·054	·055	·056	·057	·058	·059	·060	50
51	·053	·054	·055	·056	·057	·058	·059	·060	·061	·062	·063	51
52	·055	·056	·057	·058	·059	·060	·061	·062	·064	·065	·066	52
53	·057	·059	·060	·061	·062	·063	·064	·065	·066	·067	·068	53
54	·060	·061	·062	·063	·064	·065	·067	·068	·069	·070	·071	54
55	·062	·063	·064	·065	·067	·068	·069	·071	·072	·073	·074	55
56	·064	·066	·067	·068	·069	·070	·072	·073	·074	·076	·077	56
57	·067	·068	·069	·071	·072	·073	·075	·076	·077	·078	·080	57
58	·069	·071	·072	·073	·074	·076	·077	·078	·080	·081	·082	58
59	·072	·073	·074	·076	·077	·078	·080	·081	·083	·084	·085	59
60	·074	·075	·077	·078	·080	·081	·082	·084	·085	·087	·088	60
61	·076	·078	·079	·080	·082	·084	·085	·087	·088	·090	·091	61
62	·079	·080	·082	·083	·085	·086	·088	·089	·091	·092	·094	62
63	·081	·083	·084	·086	·087	·089	·090	·092	·093	·095	·096	63
64	·083	·085	·086	·088	·090	·092	·093	·095	·096	·097	·099	64
65	·086	·088	·089	·091	·092	·094	·095	·097	·099	·101	·102	65
66	·088	·090	·091	·093	·095	·097	·098	·100	·101	·103	·105	66
67	·090	·092	·094	·096	·097	·099	·101	·102	·104	·106	·108	67
68	·093	·095	·096	·098	·100	·102	·103	·105	·107	·109	·110	68
69	·095	·097	·099	·101	·102	·104	·106	·108	·110	·112	·113	69
70	·097	·099	·101	·103	·105	·107	·109	·111	·112	·114	·116	70
71	·100	·102	·103	·105	·107	·109	·111	·113	·115	·117	·119	71
72	·102	·104	·106	·108	·110	·112	·114	·116	·118	·120	·122	72
73	·104	·106	·108	·110	·112	·114	·116	·118	·120	·122	·124	73
74	·107	·109	·111	·113	·115	·117	·119	·121	·123	·125	·127	74
75	·109	·111	·113	·115	·117	·120	·122	·124	·126	·128	·130	75
76	·111	·113	·116	·118	·120	·122	·124	·126	·128	·131	·133	76
77	·114	·116	·118	·120	·122	·125	·127	·129	·131	·134	·136	77
78	·116	·118	·120	·123	·125	·127	·129	·132	·134	·136	·138	78
79	·118	·121	·123	·125	·127	·130	·132	·135	·137	·139	·141	79
80	·121	·123	·125	·128	·130	·133	·135	·137	·139	·142	·144	80
81	·123	·126	·128	·130	·132	·135	·137	·140	·142	·145	·147	81
82	·125	·128	·130	·133	·135	·138	·140	·143	·145	·147	·149	82
83	·128	·131	·133	·136	·138	·140	·142	·145	·147	·150	·152	83
84	·130	·133	·135	·138	·140	·143	·145	·148	·150	·153	·155	84
85	·132	·135	·137	·140	·143	·146	·148	·151	·153	·156	·158	84
86	·135	·138	·140	·143	·145	·148	·150	·153	·155	·158	·161	86
87	·137	·140	·142	·145	·148	·151	·153	·156	·158	·161	·163	87
88	·139	·142	·145	·148	·150	·153	·155	·158	·161	·164	·166	88
89	·142	·145	·147	·150	·153	·156	·158	·161	·164	·167	·169	89
90	·144	·147	·150	·153	·155	·158	·161	·164	·166	·169	·172	90
91	·146	·149	·152	·155	·158	·161	·163	·166	·169	·172	·175	91
92	·149	·152	·154	·157	·160	·163	·166	·169	·172	·175	·177	92
93	·151	·154	·157	·160	·163	·166	·168	·171	·174	·177	·180	93
94	·153	·156	·159	·162	·165	·168	·171	·174	·177	·180	·183	94
95	·156	·159	·162	·165	·168	·171	·174	·177	·180	·183	·186	95
96	·158	·161	·164	·167	·170	·173	·176	·179	·182	·185	·188	96
97	·160	·164	·167	·170	·173	·176	·179	·182	·185	·188	·191	97
98	·163	·166	·169	·172	·175	·178	·181	·185	·188	·191	·194	98
99	·165	·168	·171	·175	·178	·181	·184	·187	·190	·194	·197	99

NOTE.—The correction is to be subtracted in every case.

TABLE VII (*b*).

TEMPERATURE CORRECTION TO KEW PATTERN BAROMETERS.—APPLICABLE TO READINGS OF MERCURY BAROMETERS OF THE KEW PATTERN WITH BRASS SCALES EXTENDING FROM THE CISTERN TO THE TOP OF THE MERCURY COLUMN AND REDUCING THEM TO 32° F.

Attached Ther.	Barometer Reading.—Inches.											Att. Ther.
	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
°F.												°F.
35	·012	·012	·013	·013	·013	·014	·014	·014	·014	·015	·015	35
36	·014	·015	·015	·015	·016	·016	·016	·017	·017	·017	·018	36
37	·017	·017	·018	·018	·018	·019	·019	·019	·020	·020	·021	37
38	·019	·020	·020	·020	·021	·021	·022	·022	·023	·023	·023	38
39	·021	·022	·022	·023	·023	·024	·024	·025	·025	·026	·026	39
40	·024	·024	·025	·025	·026	·027	·027	·028	·028	·029	·029	40
41	·026	·027	·027	·028	·028	·029	·030	·030	·031	·031	·032	41
42	·029	·029	·030	·030	·031	·032	·032	·033	·033	·034	·035	42
43	·032	·033	·033	·034	·034	·035	·036	·036	·037	·038	·038	43
44	·034	·035	·036	·036	·037	·038	·038	·039	·040	·041	·041	44
45	·037	·037	·038	·039	·040	·040	·041	·042	·043	·043	·044	45
46	·039	·040	·041	·041	·042	·043	·044	·045	·045	·046	·047	46
47	·041	·042	·043	·044	·045	·046	·046	·047	·048	·049	·050	47
48	·044	·045	·045	·046	·047	·048	·049	·050	·051	·052	·052	48
49	·046	·047	·048	·049	·050	·051	·052	·053	·053	·054	·055	49
50	·048	·049	·050	·051	·052	·053	·054	·055	·056	·057	·058	50
51	·052	·053	·054	·055	·056	·057	·058	·059	·060	·061	·062	51
52	·054	·055	·056	·057	·058	·059	·060	·061	·063	·064	·065	52
53	·056	·058	·059	·060	·061	·062	·063	·064	·065	·066	·067	53
54	·059	·060	·061	·062	·063	·064	·066	·067	·068	·069	·070	54
55	·061	·062	·063	·064	·066	·067	·068	·070	·071	·072	·073	55
56	·063	·065	·066	·067	·068	·069	·071	·072	·073	·075	·076	56
57	·066	·067	·068	·070	·071	·072	·074	·075	·076	·077	·079	57
58	·068	·070	·071	·072	·073	·075	·076	·077	·079	·080	·081	58
59	·072	·073	·074	·076	·077	·078	·080	·081	·083	·084	·085	59
60	·074	·075	·077	·078	·080	·081	·082	·084	·085	·087	·088	60
61	·076	·078	·079	·080	·082	·084	·085	·087	·088	·090	·091	61
62	·079	·080	·082	·083	·085	·086	·088	·089	·091	·092	·094	62
63	·081	·083	·084	·086	·087	·089	·090	·092	·093	·095	·096	63
64	·083	·085	·086	·088	·090	·092	·093	·095	·096	·097	·099	64
65	·086	·088	·089	·091	·092	·094	·095	·097	·099	·101	·102	65
66	·089	·091	·092	·094	·096	·098	·099	·101	·102	·104	·106	66
67	·091	·093	·095	·097	·098	·100	·102	·103	·105	·107	·109	67
68	·094	·096	·097	·099	·101	·103	·104	·106	·108	·110	·111	68
69	·096	·098	·100	·102	·103	·105	·107	·109	·111	·113	·114	69
70	·098	·100	·102	·104	·106	·108	·110	·112	·113	·115	·117	70
71	·101	·103	·104	·106	·108	·110	·112	·114	·116	·118	·120	71
72	·103	·105	·107	·109	·111	·113	·115	·117	·119	·121	·123	72
73	·105	·107	·109	·111	·113	·115	·117	·119	·121	·123	·125	73
74	·109	·111	·113	·115	·117	·119	·121	·123	·125	·127	·129	74
75	·111	·113	·115	·117	·119	·122	·124	·126	·128	·130	·132	75
76	·113	·115	·118	·120	·122	·124	·126	·128	·130	·133	·135	76
77	·116	·118	·120	·122	·124	·127	·129	·131	·133	·136	·138	77
78	·118	·120	·122	·125	·127	·129	·131	·134	·136	·138	·140	78
79	·120	·123	·125	·127	·129	·132	·134	·137	·139	·141	·143	79
80	·123	·125	·127	·130	·132	·135	·137	·139	·141	·144	·146	80
81	·125	·128	·130	·132	·134	·137	·139	·142	·144	·147	·149	81
82	·128	·131	·133	·136	·138	·141	·143	·146	·148	·150	·152	82
83	·131	·134	·136	·139	·141	·143	·145	·148	·150	·153	·155	83
84	·133	·136	·138	·141	·143	·146	·148	·151	·153	·156	·158	84

NOTE—The correction is to be subtracted in every case.

TABLE VII (*b*).—*continued*.

TEMPERATURE CORRECTION TO KEW PATTERN BAROMETERS—*continued*.

Attached Ther.	Barometer Reading.—Inches.											Att. Ther.
	26•0	26•5	27•0	27•5	28•0	28•5	29•0	29•5	30•0	30•5	31•0	
°F.												°F.
85	•135	•138	•140	•143	•146	•149	•151	•154	•156	•159	•161	85
86	•138	•141	•143	•146	•148	•151	•153	•156	•158	•161	•164	86
87	•140	•143	•145	•148	•151	•154	•156	•159	•161	•164	•166	87
88	•142	•145	•148	•151	•153	•156	•158	•161	•164	•167	•169	88
89	•145	•148	•150	•153	•156	•159	•161	•164	•167	•170	•172	89
90	•148	•151	•154	•157	•159	•162	•165	•168	•170	•173	•176	90
91	•150	•153	•156	•159	•162	•165	•167	•170	•173	•176	•179	91
92	•153	•156	•158	•161	•164	•167	•170	•173	•176	•179	•181	92
93	•155	•158	•161	•164	•167	•170	•172	•175	•178	•181	•184	93
94	•157	•160	•163	•166	•169	•172	•175	•178	•181	•184	•187	94
95	•160	•163	•166	•169	•172	•175	•178	•181	•184	•187	•190	95
96	•162	•165	•168	•171	•174	•177	•180	•183	•186	•189	•192	96
97	•164	•168	•171	•174	•177	•180	•183	•186	•189	•192	•195	97
98	•168	•171	•174	•177	•180	•183	•186	•190	•193	•196	•199	98
99	•170	•173	•176	•180	•183	•186	•189	•192	•195	•199	•202	99
100	•172	•176	•179	•182	•185	•189	•192	•195	•198	•202	•205	100
								.197	.200			
								.200	.203			
								.203	.206			
								.206	.209			
								.209	.212			

TABLE VIII.

CORRECTIONS FOR REDUCING BAROMETER READINGS TO STANDARD GRAVITY IN LATITUDE 45°.

Lat. N. or S.	Correction.		Lat. N. or S.	Correction.		Lat. N. or S.	Correction.		Lat. N. or S.	Correction.	
	At 27 in.	At 30 in.		At 27 in.	At 30 in.		At 27 in.	At 30 in.		At 27 in.	At 30 in.
°			°			°			°		
0	−•070	−•078	23	−•049	−•054	46	+•002	+•003	69	+•052	+•058
1	•070	•078	24	•047	•052	47	•005	•005	70	•054	•060
2	•070	•078	25	•045	•050	48	•007	•008	71	•055	•061
3	•070	•077	26	•043	•048	49	•010	•011	72	•057	•063
4	•069	•077	27	•041	•046	50	•012	•013	73	•058	•064
5	•069	•077	28	•039	•043	51	•015	•016	74	•059	•066
6	•068	•076	29	•037	•041	52	•017	•019	75	•061	•067
7	•068	•075	30	•035	•039	53	•019	•021	76	•062	•069
8	•067	•075	31	•033	•036	54	•022	•024	77	•063	•070
9	•067	•074	32	•031	•034	55	•024	•027	78	•064	•071
10	•066	•073	33	•028	•032	56	•026	•029	79	•065	•072
11	•065	•072	34	•026	•029	57	•028	•032	80	•066	•073
12	•064	•071	35	•024	•027	58	•031	•034	81	•067	•074
13	•063	•070	36	•022	•024	59	•033	•036	82	•067	•075
14	•062	•069	37	•019	•021	60	•035	•039	83	•068	•075
15	•061	•067	38	•017	•019	61	•037	•041	84	•068	•076
16	•059	•066	39	•015	•016	62	•039	•043	85	•069	•077
17	•058	•064	40	•012	•013	63	•041	•046	86	•069	•077
18	•057	•063	41	•010	•011	64	•043	•048	87	•070	•077
19	•055	•061	42	•007	•008	65	•045	•050	88	•070	•078
20	•054	•060	43	•005	•005	66	•047	•052	89	•070	•078
21	•052	•058	44	−•002	−•003	67	•049	•054	90	+•070	+•078
22	−•050	−•056	45	•000	•000	68	+•050	+•056			

TABLE IX.

Reduction of Barometer Readings to Mean Sea Level.

Reading at Station Level, 27 inches.

Height in Feet.	TEMPERATURE OF AIR. (Dry bulb in screen.)											Height in Feet.
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
10	·011	·011	·011	·010	·010	·010	·010	·009	·009	·009	·009	10
20	·023	·022	·021	·021	·021	·020	·020	·019	·019	·018	·018	20
30	·034	·033	·032	·032	·031	·030	·029	·029	·028	·028	·027	30
40	·044	·043	·042	·041	·040	·040	·039	·038	·038	·037	·036	40
50	·056	·054	·053	·052	·050	·049	·049	·048	·047	·046	·045	50
60	·067	·065	·064	·062	·061	·059	·058	·058	·056	·055	·055	60
70	·078	·076	·075	·073	·071	·069	·068	·067	·066	·064	·064	70
80	·088	·086	·085	·083	·082	·080	·078	·076	·075	·073	·073	80
90	·100	·097	·096	·094	·092	·091	·088	·085	·085	·083	·082	90
100	·111	·108	·106	·104	·102	·100	·097	·096	·094	·092	·091	100
110	·122	·119	·116	·115	·112	·110	·107	·105	·103	·101	·100	110
120	·133	·130	·127	·124	·123	·120	·117	·116	·113	·110	·109	120
130	·143	·140	·138	·135	·132	·129	·126	·123	·121	·120	·118	130
140	·154	·151	·148	·145	·143	·139	·136	·133	·132	·129	·127	140
150	·165	·162	·159	·156	·152	·148	·146	·143	·141	·138	·135	150
160	·176	·173	·170	·166	·162	·159	·156	·153	·150	·147	·144	160
170	·188	·184	·180	·177	·172	·169	·166	·162	·160	·156	·153	170
180	·199	·194	·191	·186	·182	·178	·175	·172	·168	·166	·163	180
190	·210	·205	·201	·196	·193	·188	·184	·182	·178	·175	·172	190
200	·221	·216	·211	·207	·202	·199	·195	·191	·188	·184	·181	200
210	·232	·227	·221	·217	·212	·209	·204	·201	·197	·193	·190	210
220	·243	·238	·232	·228	·223	·219	·214	·211	·207	·203	·199	220
230	·254	·248	·243	·238	·233	·229	·224	·220	·217	·212	·208	230
240	·265	·259	·254	·249	·244	·238	·234	·229	·226	·222	·218	240
250	·275	·270	·265	·259	·254	·248	·244	·239	·236	·232	·227	250
260	·287	·281	·275	·269	·264	·258	·254	·250	·245	·241	·236	260
270	·298	·292	·286	·280	·274	·269	·264	·260	·255	·250	·245	270
280	·310	·302	·297	·290	·284	·279	·274	·269	·264	·260	·255	280
290	·320	·313	·308	·301	·295	·290	·284	·279	·274	·269	·264	290
300	·332	·324	·319	·310	·305	·300	·294	·289	·283	·278	·273	300
310	·344	·336	·329	·321	·315	·310	·304	·299	·292	·287	·282	310
320	·355	·346	·340	·332	·326	·320	·314	·309	·301	·296	·291	320
330	·366	·358	·351	·343	·336	·329	·323	·318	·311	·306	·300	330
340	·377	·369	·362	·354	·346	·338	·333	·328	·320	·315	·309	340
350	·389	·381	·373	·364	·356	·348	·343	·337	·329	·324	·318	350
360	·400	·391	·383	·374	·366	·358	·353	·346	·339	·333	·328	360
370	·410	·402	·393	·385	·377	·369	·363	·355	·349	·342	·337	370
380	·421	·413	·403	·395	·387	·379	·372	·365	·358	·352	·346	380
390	·432	·424	·414	·406	·398	·390	·382	·374	·368	·361	·355	390
400	·443	·435	·424	·416	·408	·400	·391	·383	·378	·370	·364	400
410	·454	·445	·435	·427	·418	·409	·401	·393	·387	·379	·373	410
420	·465	·456	·445	·437	·428	·420	·411	·403	·396	·388	·382	420
430	·477	·467	·456	·448	·438	·430	·420	·412	·406	·398	·392	430
440	·488	·478	·467	·459	·449	·441	·430	·422	·415	·407	·401	440
450	·499	·489	·478	·470	·459	·451	·440	·432	·424	·416	·410	450
460	·511	·499	·489	·480	·469	·461	·450	·442	·434	·426	·419	460
470	·522	·510	·499	·490	·480	·471	·461	·452	·444	·436	·429	470
480	·534	·521	·510	·500	·490	·480	·471	·461	·453	·445	·438	480
490	·544	·532	·521	·511	·500	·490	·481	·471	·463	·454	·447	490
500	·556	·543	·532	·521	·510	·499	·491	·481	·473	·464	·456	500

TABLE IX.—*continued.*

Reduction of Barometer Readings to Mean Sea Level.

Reading at Station Level, 27 inches.

Height in Feet.	TEMPERATURE OF AIR. (Dry bulb in screen.)											Height in Feet.
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
500	•556	•543	•532	•521	•510	•499	•491	•481	•473	•464	•456	500
510	•568	•554	•543	•532	•520	•509	•501	•490	•482	•473	•466	510
520	•579	•565	•553	•543	•531	•520	•511	•500	•492	•482	•475	520
530	•591	•577	•564	•554	•541	•530	•520	•509	•501	•492	•484	530
540	•601	•588	•575	•564	•552	•541	•530	•519	•511	•501	•493	540
550	•613	•599	•586	•575	•562	•551	•540	•529	•521	•510	•502	550
560	•624	•610	•597	•585	•572	•561	•550	•539	•530	•519	•511	560
570	•634	•621	•607	•596	•582	•571	•561	•549	•539	•528	•520	570
580	•645	•632	•618	•606	•592	•581	•571	•558	•549	•538	•530	580
590	•656	•643	•629	•617	•603	•592	•581	•568	•558	•547	•539	590
600	•667	•653	•640	•626	•613	•602	•591	•578	•567	•556	•548	600
610	•677	•665	•651	•637	•624	•612	•601	•588	•577	•566	•557	610
620	•689	•676	•662	•648	•634	•623	•611	•598	•587	•576	•566	620
630	•701	•688	•672	•659	•645	•633	•620	•607	•596	•585	•576	630
640	•712	•698	•683	•670	•656	•643	•630	•616	•606	•595	•585	640
650	•724	•710	•694	•680	•667	•653	•640	•626	•616	•605	•594	650
660	•735	•721	•705	•690	•677	•663	•650	•636	•625	•614	•603	660
670	•746	•732	•715	•701	•688	•673	•660	•647	•635	•623	•612	670
680	•758	•742	•726	•711	•697	•682	•669	•657	•644	•633	•622	680
690	•769	•753	•737	•722	•708	•692	•679	•668	•654	•642	•631	690
700	•780	•764	•748	•732	•718	•702	•688	•678	•664	•651	•640	700
710	•792	•776	•759	•742	•728	•712	•698	•688	•674	•661	•649	710
720	•803	•787	•769	•753	•739	•723	•709	•697	•684	•670	•658	720
730	•815	•798	•780	•764	•749	•733	•719	•706	•693	•679	•667	730
740	•825	•809	•791	•775	•760	•743	•730	•716	•703	•689	•677	740
750	•837	•821	•802	•786	•769	•753	•740	•726	•713	•699	•686	750
760	•849	•832	•813	•796	•779	•763	•750	•736	•722	•708	•695	760
770	•859	•842	•823	•807	•790	•774	•760	•746	•731	•717	•704	770
780	•871	•853	•834	•818	•800	•784	•769	•755	•741	•727	•714	780
790	•882	•864	•845	•829	•811	•795	•778	•765	•750	•736	•723	790
800	•894	•875	•856	•840	•821	•805	•788	•775	•759	•745	•732	800
810	•905	•886	•867	•850	•832	•814	•798	•785	•769	•755	•741	810
820	•916	•897	•877	•860	•842	•825	•809	•795	•778	•765	•750	820
830	•928	•909	•888	•870	•853	•835	•819	•804	•787	•774	•759	830
840	•939	•920	•899	•881	•864	•846	•830	•814	•797	•784	•769	840
850	•950	•931	•910	•891	•875	•856	•840	•823	•807	•794	•778	850
860	•962	•942	•922	•902	•885	•866	•850	•833	•817	•803	•787	860
870	•974	•953	•932	•913	•895	•877	•860	•843	•827	•812	•797	870
880	•986	•964	•944	•923	•905	•886	•870	•852	•836	•822	•806	880
890	•998	•975	•955	•934	•916	•897	•881	•862	•846	•831	•816	890
900	1•010	•985	•967	•945	•926	•907	•891	•872	•856	•840	•825	900
910	1•021	•997	•977	•956	•936	•917	•901	•882	•866	•850	•834	910
920	1•032	1•008	•988	•967	•947	•928	•911	•893	•876	•859	•844	920
930	1•044	1•020	•999	•977	•957	•938	•920	•903	•885	•868	•853	930
940	1•055	1•030	1•010	•988	•967	•949	•930	•913	•895	•878	•862	940
950	1•066	1•042	1•021	•999	•977	•958	•940	•924	•904	•888	•872	950
960	1•078	1•054	1•031	1•010	•988	•968	•950	•933	•914	•897	•881	960
970	1•089	1•065	1•042	1•021	•999	•979	•960	•943	•925	•906	•890	970
980	1•101	1•076	1•053	1•031	1•010	•989	•970	•952	•934	•916	•900	980
990	1•111	1•087	1•064	1•042	1•021	1•000	•981	•962	•943	•925	•909	990
1000	1•123	1•099	1•075	1•053	1•031	1•010	•991	•972	•953	•934	•918	1000

TABLE IX.—*continued.*

Reduction of Barometer Readings to Mean Sea Level.

Reading at Station Level, 30 inches.

Height in feet.	TEMPERATURE OF AIR. (Dry bulb in screen.) 0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	Height in feet.
10	·012	·012	·012	·011	·011	·011	·011	·010	·010	·010	·010	10
20	·025	·024	·023	·023	·023	·022	·022	·021	·021	·020	·020	20
30	·037	·036	·035	·035	·034	·033	·032	·032	·031	·031	·030	30
40	·049	·048	·047	·046	·045	·044	·043	·042	·042	·041	·040	40
50	·062	·060	·059	·058	·056	·055	·054	·053	·052	·051	·050	50
60	·074	·072	·071	·069	·068	·066	·065	·064	·062	·061	·060	60
70	·086	·084	·083	·081	·079	·077	·076	·074	·073	·071	·070	70
80	·098	·096	·094	·092	·091	·089	·087	·085	·083	·081	·080	80
90	·111	·108	·106	·104	·102	·101	·098	·095	·094	·092	·091	90
100	·123	·120	·118	·115	·113	·111	·108	·106	·104	·102	·101	100
110	·135	·132	·129	·127	·124	·122	·119	·116	·114	·112	·111	110
120	·147	·144	·141	·138	·136	·133	·130	·127	·125	·122	·121	120
130	·159	·156	·153	·150	·147	·143	·140	·137	·135	·133	·131	130
140	·171	·168	·164	·161	·158	·154	·151	·148	·146	·143	·141	140
150	·183	·180	·176	·173	·169	·165	·162	·159	·156	·153	·151	150
160	·196	·192	·188	·184	·180	·176	·173	·170	·166	·163	·161	160
170	·209	·204	·200	·196	·191	·187	·184	·180	·177	·173	·171	170
180	·221	·216	·212	·207	·202	·198	·195	·191	·187	·184	·181	180
190	·233	·228	·223	·218	·214	·209	·205	·202	·198	·194	·191	190
200	·246	·240	·235	·230	·225	·221	·217	·212	·209	·205	·201	200
210	·258	·252	·246	·241	·236	·232	·227	·223	·219	·215	·212	210
220	·270	·264	·258	·253	·248	·243	·238	·234	·230	·226	·222	220
230	·282	·276	·270	·265	·259	·254	·249	·245	·241	·236	·232	230
240	·294	·288	·282	·277	·271	·265	·260	·255	·251	·247	·242	240
250	·306	·300	·294	·288	·282	·276	·271	·266	·262	·258	·252	250
260	·319	·312	·306	·299	·293	·287	·282	·278	·272	·268	·262	260
270	·331	·324	·318	·311	·305	·299	·293	·289	·283	·278	·273	270
280	·344	·336	·330	·322	·316	·310	·305	·299	·293	·289	·283	280
290	·356	·348	·342	·334	·328	·322	·316	·310	·304	·299	·293	290
300	·369	·360	·354	·345	·339	·333	·327	·321	·315	·309	·303	300
310	·382	·373	·366	·357	·350	·344	·338	·332	·325	·319	·313	310
320	·394	·385	·378	·369	·362	·355	·349	·343	·335	·329	·324	320
330	·407	·398	·390	·381	·373	·365	·359	·353	·346	·340	·334	330
340	·419	·410	·402	·393	·385	·376	·370	·364	·356	·350	·344	340
350	·432	·423	·414	·405	·396	·387	·381	·375	·366	·360	·354	350
360	·444	·435	·425	·416	·407	·398	·392	·385	·377	·370	·364	360
370	·456	·447	·437	·428	·419	·410	·403	·395	·388	·380	·375	370
380	·468	·459	·448	·439	·430	·421	·413	·406	·398	·391	·385	380
390	·480	·471	·460	·451	·442	·433	·424	·416	·409	·401	·395	390
400	·492	·483	·471	·462	·453	·444	·435	·426	·420	·411	·405	400
410	·505	·495	·483	·474	·464	·455	·446	·437	·430	·421	·415	410
420	·517	·507	·495	·486	·476	·467	·457	·448	·440	·431	·426	420
430	·530	·519	·507	·498	·487	·478	·467	·458	·451	·442	·436	430
440	·542	·531	·519	·510	·499	·490	·478	·469	·461	·452	·446	440
450	·555	·543	·531	·522	·510	·501	·489	·480	·471	·462	·456	450
460	·568	·555	·543	·533	·521	·512	·500	·491	·482	·473	·466	460
470	·580	·567	·555	·545	·533	·523	·512	·502	·493	·484	·477	470
480	·593	·579	·567	·556	·544	·533	·523	·512	·503	·494	·487	480
490	·605	·591	·579	·568	·556	·544	·535	·523	·514	·505	·497	490
500	·618	·603	·591	·579	·567	·555	·546	·534	·525	·516	·507	500

TABLE IX.—*continued.*

Reduction of Barometer Readings to Mean Sea Level.

Reading at Station Level, 30 inches.

Height in Feet.	TEMPERATURE OF AIR. (Dry bulb in screen.)											Height in Feet.
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
500	•618	•603	•591	•579	•567	•555	•546	•534	•525	•516	•507	500
510	•631	•616	•603	•591	•578	•566	•557	•545	•536	•526	•517	510
520	•643	•628	•615	•603	•590	•578	•568	•556	•547	•536	•528	520
530	•656	•641	•627	•615	•601	•589	•578	•566	•557	•547	•538	530
540	•668	•653	•639	•627	•613	•601	•589	•577	•568	•557	•548	540
550	•681	•666	•651	•639	•624	•612	•600	•588	•579	•567	•558	550
560	•693	•678	•663	•650	•635	•623	•611	•599	•589	•577	•568	560
570	•705	•690	•675	•662	•647	•635	•623	•610	•599	•587	•578	570
580	•717	•702	•687	•673	•658	•646	•634	•620	•610	•598	•589	580
590	•729	•714	•699	•685	•670	•658	•646	•631	•620	•608	•599	590
600	•741	•726	•711	•896	•681	•669	•657	•642	•630	•618	•609	600
610	•754	•739	•723	•708	•693	•680	•668	•653	•641	•629	•619	610
620	•766	•751	•735	•720	•705	•692	•679	•664	•652	•640	•629	620
630	•779	•764	•747	•732	•717	•703	•689	•674	•662	•650	•640	630
640	•791	•776	•759	•744	•729	•715	•700	•685	•673	•661	•650	640
650	•804	•789	•771	•756	•741	•726	•711	•696	•684	•672	•660	650
660	•817	•801	•783	•767	•752	•737	•722	•707	•695	•682	•670	660
670	•829	•813	•795	•779	•764	•748	•733	•719	•706	•692	•681	670
680	•842	•825	•807	•790	•775	•758	•743	•730	•716	•703	•691	680
690	•854	•837	•819	•802	•787	•769	•754	•742	•727	•713	•701	690
700	•867	•849	•831	•813	•798	•780	•765	•753	•738	•723	•711	700
710	•880	•862	•843	•825	•809	•791	•776	•764	•749	•734	•721	710
720	•892	•874	•855	•837	•821	•803	•788	•775	•760	•745	•732	720
730	•905	•887	•867	•849	•832	•814	•799	•785	•770	•755	•742	730
740	•917	•899	•879	•861	•844	•826	•811	•796	•781	•766	•752	740
750	•930	•912	•891	•873	•855	•837	•822	•807	•792	•777	•762	750
760	•943	•924	•903	•885	•866	•848	•833	•818	•802	•787	•772	760
770	•955	•936	•915	•897	•878	•860	•844	•829	•812	•797	•783	770
780	•968	•948	•927	•909	•889	•871	•854	•839	•823	•808	•793	780
790	•980	•960	•939	•921	•901	•883	•865	•850	•833	•818	•803	790
800	•993	•972	•951	•933	•912	•894	•876	•861	•843	•828	•813	800
810	1•006	•985	•963	•944	•924	•905	•887	•872	•854	•839	•824	810
820	1•018	•997	•975	•956	•936	•917	•899	•883	•865	•850	•834	820
830	1•031	1•010	•987	•967	•948	•928	•910	•893	•875	•860	•844	830
840	1•043	1•022	•999	•979	•960	•940	•922	•904	•886	•871	•854	840
850	1•056	1•035	1•011	•990	•972	•951	•933	•915	•897	•882	•865	850
860	1•069	1•047	1•024	1•002	•983	•962	•944	•926	•908	•892	•875	860
870	1•082	1•059	1•036	1•014	•995	•974	•956	•937	•919	•902	•885	870
880	1•096	1•071	1•049	1•026	1•006	•985	•967	•947	•929	•913	•895	880
890	1•109	1•083	1•061	1•038	1•018	•997	•979	•958	•940	•923	•906	890
900	1•122	1•095	1•074	1•050	1•029	1•008	•990	•969	•951	•933	•916	900
910	1•135	1•108	1•086	1•062	1•040	1•019	1•001	•980	•962	•944	•926	910
920	1•147	1•120	1•098	1•074	1•052	1•031	1•012	•992	•973	•955	•937	920
930	1•160	1•133	1•110	1•086	1•063	1•042	1•022	1•003	•983	•965	•947	930
940	1•172	1•145	1•122	1•098	1•075	1•054	1•033	1•015	•994	•976	•957	940
950	1•185	1•158	1•134	1•110	1•086	1•065	1•044	1•026	1•005	•987	•968	950
960	1•198	1•171	1•146	1•122	1•098	1•076	1•055	1•037	1•016	•997	•978	960
970	1•210	1•183	1•158	1•134	1•110	1•088	1•067	1•048	1•027	1•007	•989	970
980	1•223	1•196	1•170	1•146	1•122	1•099	1•078	1•058	1•037	1•018	•999	980
990	1•235	1•208	1•182	1•158	1•134	1•111	1•090	1•069	1•048	1•028	1•009	990
1000	1•248	1•221	1•194	1•170	1•146	1•122	1•101	1•080	1•059	1•038	1•020	1000

TABLE X.

EQUIVALENTS IN MILLIBARS OF INCHES OF MERCURY AT 32° F. AND LATITUDE 45°.

The fundamental equations are :—

g_{45}=980·617 cm./sec^2.
density of mercury at normal freezing point of water=13·5955.
1 mercury inch=33·8632 millibars.
1 millibar=0·0295306 mercury inches=0·750076 mercury millimeters.
using 1 inch=2·54000 cm.
1 cm.=0·393701 inch.

and taking the expression " mercury inch " to denote the pressure due to a column of mercury one inch high under standard conditions of temperature (freezing point of water) and gravity (latitude 45°).

Mercury, Inches.	0	1	2	3	4	5	6	7	8	9
	Millibars.									
0·0	0·0	0·3	0·7	1·0	1·4	1·7	2·1	2·4	2·7	3·1
0·1	3·4	3·7	4·1	4·4	4·7	5·1	5·4	5·8	6·1	6·4
0·2	6·8	7·1	7·5	7·8	8·2	8·5	8·8	9·2	9·5	9·8
0·3	10·2	10·5	10·9	11·2	11·5	11·9	12·2	12·6	12·9	13·2
0·4	13·6	13·9	14·2	14·6	14·9	15·3	15·6	15·9	16·3	16·6
0·5	16·9	17·3	17·6	18·0	18·3	18·6	19·0	19·3	19·7	20·0
0·6	20·3	20·7	21·0	21·4	21·7	22·0	22·4	22·7	23·1	23·4
0·7	23·7	24·1	24·4	24·7	25·1	25·4	25·8	26·1	26·4	26·8
0·8	27·1	27·5	27·8	28·1	28·5	28·8	29·1	29·5	29·8	30·2
0·9	30·5	30·8	31·2	31·5	31·9	32·2	32·5	32·9	33·2	33·5
1·0	33·9	34·2	34·6	34·9	35·2	35·6	35·9	36·3	36·6	36·9

Mercury, Inches.	1	2	3	4	5	6	7	8	9	10
Millibars	33·9	67·7	101·6	135·5	169·3	203·2	237·0	270·9	304·8	338·6
Mercury, Inches.	11	12	13	14	15	16	17	18	19	20
Millibars	372·5	406·4	440·2	474·1	507·9	541·8	575·7	609·5	643·4	677·3

TABLE X.—*continued.*

EQUIVALENTS IN MILLIBARS OF INCHES OF MERCURY AT 32° F. AND LATITUDE 45°.

Mercury, Inches.	0	1	2	3	4	5	6	7	8	9
	Millibars.									
27·0	914·3	914·6	915·0	915·3	915·7	916·0	916·3	916·7	917·0	917·4
27·1	917·7	918·0	918·4	918·7	919·0	919·4	919·7	920·1	920·4	920·7
27·2	921·1	921·4	921·8	922·1	922·4	922·8	923·1	923·4	923·8	924·1
27·3	924·5	924·8	925·1	925·5	925·8	926·2	926·5	926·8	927·2	927·5
27·4	927·9	928·2	928·5	928·9	929·2	929·5	929·9	930·2	930·6	930·9
27·5	931·2	931·6	931·9	932·3	932·6	932·9	933·3	933·6	933·9	934·3
27·6	934·6	935·0	935·3	935·6	936·0	936·3	936·7	937·0	937·3	937·7
27·7	938·0	938·3	938·7	939·0	939·4	939·7	940·0	940·4	940·7	941·1
27·8	941·4	941·7	942·1	942·4	942·8	943·1	943·4	943·8	944·1	944·4
27·9	944·8	945·1	945·5	945·8	946·1	946·5	946·8	947·2	947·5	947·8
28·0	948·2	948·5	948·8	949·2	949·5	949·9	950·2	950·5	950·9	951·2
28·1	951·6	951·9	952·2	952·6	952·9	953·2	953·6	953·9	954·3	954·6
28·2	954·9	955·3	955·6	956·0	956·3	956·6	957·0	957·3	957·7	958·0
28·3	958·3	958·7	959·0	959·3	959·7	960·0	960·3	960·7	961·0	961·4
28·4	961·7	962·1	962·4	962·7	963·1	963·4	963·7	964·1	964·4	964·8
28·5	965·1	965·4	965·8	966·1	966·5	966·8	967·1	967·5	967·8	968·1
28·6	968·5	968·8	969·2	969·5	969·8	970·2	970·5	970·9	971·2	971·5
28·7	971·9	972·2	972·6	972·9	973·2	973·6	973·9	974·2	974·6	974·9
28·8	975·3	975·6	975·9	976·3	976·6	976·9	977·3	977·6	978·0	978·3
28·9	978·6	979·0	979·3	979·7	980·0	980·3	980·7	981·0	981·4	981·7
29·0	982·0	982·4	982·7	983·0	983·4	983·7	984·1	984·4	984·7	985·1
29·1	985·4	985·8	986·1	986·4	986·8	987·1	987·5	987·8	988·1	988·5
29·2	988·8	989·1	989·5	989·8	990·2	990·5	990·8	991·2	991·5	991·9
29·3	992·2	992·5	992·9	993·2	993·5	993·9	994·2	994·6	994·9	995·2
29·4	995·6	995·9	996·3	996·6	996·9	997·3	997·6	997·9	998·3	998·6
29·5	999·0	999·3	999·6	1000·0	1000·3	1000·7	1001·0	1001·3	1001·7	1002·0
29·6	1002·4	1002·7	1003·0	1003·4	1003·7	1004·0	1004·4	1004·7	1005·1	1005·4
29·7	1005·7	1006·1	1006·4	1006·8	1007·1	1007·4	1007·8	1008·1	1008·4	1008·8
29·8	1009·1	1009·5	1009·8	1010·1	1010·5	1010·8	1011·2	1011·5	1011·8	1012·2
29·9	1012·5	1012·8	1013·2	1013·5	1013·9	1014·2	1014·5	1014·9	1015·2	1015·6
30·0	1015·9	1016·2	1016·6	1016·9	1017·3	1017·6	1017·9	1018·3	1018·6	1018·9
30·1	1019·3	1019·6	1020·0	1020·3	1020·6	1021·0	1021·3	1021·7	1022·0	1022·3
30·2	1022·7	1023·0	1023·3	1023·7	1024·0	1024·4	1024·7	1025·0	1025·4	1025·7
30·3	1026·1	1026·4	1026·7	1027·1	1027·4	1027·7	1028·1	1028·4	1028·8	1029·1
30·4	1029·4	1029·8	1030·1	1030·5	1030·8	1031·1	1031·5	1031·8	1032·2	1032·5
30·5	1032·8	1033·2	1033·5	1033·8	1034·2	1034·5	1034·9	1035·2	1035·5	1035·9
30·6	1036·2	1036·6	1036·9	1037·2	1037·6	1037·9	1038·2	1038·6	1038·9	1039·3
30·7	1039·6	1039·9	1040·3	1040·6	1041·0	1041·3	1041·6	1042·0	1042·3	1042·6
30·8	1043·0	1043·3	1043·7	1044·0	1044·3	1044·7	1045·0	1045·4	1045·7	1046·0
30·9	1046·4	1046·7	1047·1	1047·4	1047·7	1048·1	1048·4	1048·7	1049·1	1049·4

TABLE XI. A.

Temperature Correction of the Fortin Barometer.

Corrections to be applied to the Readings of *Fortin Mercury Barometers* for given differences between the fiducial temperature and the temperature shown by the attached thermometer.

If the fiducial temperature is $\left\{\begin{matrix}\text{above}\\\text{below}\end{matrix}\right\}$ the actual temperature $\left\{\begin{matrix}\text{add}\\\text{subtract}\end{matrix}\right\}$ the correction. The result gives the pressure in millibars.

Difference between the fiducial temperature and the reading of the attached thermometer.	BAROMETER READINGS.									
	860	880	900	920	940	960	980	1000	1020	1040
a					Correction.					
1	·14	·14	·15	·15	·15	·16	·16	·16	·17	·17
2	·28	·29	·29	·30	·31	·31	·32	·33	·33	·34
3	·42	·43	·44	·45	·46	·47	·48	·49	·50	·51
4	·56	·57	·60	·61	·63	·64	·65	·65	·67	·68
5	·70	·72	·73	·75	·77	·78	·80	·82	·83	·85
6	·84	·86	·88	·90	·92	·94	·96	·98	1·00	1·02
7	·98	1·00	1·03	1·05	1·07	1·10	1·12	1·14	1·16	1·19
8	1·12	1·15	1·17	1·20	1·23	1·25	1·28	1·30	1·33	1·36
9	1·26	1·29	1·32	1·35	1·38	1·41	1·44	1·47	1·50	1·53
10	1·40	1·43	1·47	1·50	1·53	1·56	1·60	1·63	1·66	1·70
11	1·54	1·58	1·61	1·65	1·69	1·72	1·76	1·79	1·83	1·86
12	1·68	1·72	1·76	1·80	1·84	1·88	1·92	1·96	2·00	2·03
13	1·82	1·86	1·91	1·95	1·99	2·03	2·08	2·12	2·16	2·20
14	1·96	2·01	2·05	2·10	2·15	2·19	2·24	2·28	2·33	2·37
15	2·10	2·15	2·20	2·25	2·30	2·35	2·40	2·45	2·49	2·54
16	2·24	2·30	2·35	2·40	2·45	2·50	2·56	2·61	2·66	2·71
17	2·38	2·44	2·49	2·55	2·60	2·66	2·72	2·77	2·83	2·88
18	2·52	2·58	2·64	2·70	2·76	2·82	2·88	2·93	2·99	3·05
19	2·66	2·73	2·79	2·85	2·91	2·97	3·04	3·10	3·16	3·22
20	2·80	2·87	2·93	3·00	3·06	3·13	3·19	3·26	3·33	3·39
21	2·94	3·01	3·08	3·15	3·22	3·29	3·35	3·42	3·49	3·56
22	3·08	3·16	3·23	3·30	3·37	3·44	3·51	3·59	3·66	3·73
23	3·22	3·30	3·37	3·45	3·52	3·60	3·67	3·75	3·82	3·90
24	3·36	3·44	3·52	3·60	3·68	3·76	3·83	3·91	3·99	4·07
25	3·50	3·59	3·67	3·75	3·83	3·91	3·99	4·08	4·16	4·24
26	3·64	3·73	3·81	3·90	3·98	4·07	4·15	4·24	4·32	4·41
27	3·78	3·87	3·96	4·05	4·14	4·22	4·31	4·40	4·49	4·58
28	3·93	4·02	4·11	4·20	4·28	4·38	4·47	4·56	4·66	4·75
29	4·07	4·16	4·25	4·35	4·44	4·53	4·63	4·73	4·82	4·92
30	4·21	4·30	4·40	4·50	4·60	4·69	4·79	4·89	4·99	5·09

TABLE XI. B.

Temperature-Correction of the Kew Pattern Barometer.

Corrections to be applied to the Readings of *Kew Pattern Mercury Barometers* for given differences between the fiducial temperature and the temperature shown by the attached thermometer.

If the fiducial temperature is $\left\{ \begin{array}{c} \text{above} \\ \text{below} \end{array} \right\}$ the actual temperature $\left\{ \begin{array}{c} \text{add} \\ \text{subtract} \end{array} \right\}$ the correction. The result gives the pressure in millibars.

Difference between the fiducial temperature and the reading of the attached thermometer.	BAROMETER READINGS.									
	860	880	900	920	940	960	980	1000	1020	1040
a	Corrections.									
1	·15	·15	·15	·16	·16	·16	·17	·17	·17	·18
2	·30	·30	·31	·32	·32	·33	·34	·34	·35	·36
3	·44	·45	·46	·47	·48	·49	·50	·51	·52	·53
4	·59	·61	·62	·63	·64	·66	·67	·68	·70	·71
5	·74	·76	·77	·79	·81	·82	·84	·86	·87	·89
6	·89	·91	·93	·95	·97	·99	1·01	1·03	1·05	1·07
7	1·04	1·06	1·08	1·11	1·13	1·15	1·17	1·20	1·22	1·24
8	1·19	1·21	1·24	1·26	1·29	1·32	1·34	1·37	1·39	1·42
9	1·33	1·36	1·39	1·42	1·45	1·48	1·51	1·54	1·57	1·60
10	1·48	1·51	1·55	1·58	1·61	1·64	1·68	1·71	1·74	1·78
11	1·63	1·67	1·70	1·74	1·77	1·81	1·85	1·88	1·92	1·95
12	1·78	1·82	1·86	1·90	1·93	1·97	2·01	2·05	2·09	2·13
13	1·92	1·97	2·01	2·05	2·10	2·14	2·18	2·22	2·27	2·31
14	2·07	2·12	2·17	2·21	2·26	2·30	2·35	2·39	2·44	2·49
15	2·22	2·27	2·32	2·37	2·42	2·47	2·52	2·57	2·61	2·66
16	2·37	2·42	2·48	2·53	2·58	2·63	2·68	2·74	2·79	2·84
17	2·52	2·57	2·63	2·69	2·74	2·80	2·85	2·91	2·96	3·02
18	2·67	2·73	2·78	2·84	2·90	2·96	3·02	3·08	3·14	3·20
19	2·82	2·88	2·94	3·00	3·06	3·13	3·19	3·25	3·31	3·37
20	2·96	3·03	3·09	3·16	3·22	3·29	3·35	3·42	3·49	3·55
21	3·11	3·18	3·25	3·32	3·39	3·45	3·52	3·59	3·65	3·73
22	3·26	3·33	3·41	3·48	3·55	3·62	3·69	3·76	3·83	3·91
23	3·41	3·48	3·56	3·63	3·71	3·78	3·86	3·93	4·01	4·08
24	3·56	3·63	3·71	3·79	3·87	3·95	4·03	4·10	4·18	4·26
25	3·70	3·79	3·87	3·95	4·03	4·11	4·19	4·28	4·36	4·44
26	3·85	3·94	4·02	4·11	4·19	4·28	4·36	4·45	4·53	4·63
27	4·00	4·09	4·18	4·26	4·35	4·44	4·53	4·62	4·71	4·79
28	4·15	4·24	4·33	4·42	4·51	4·61	4·70	4·79	4·88	4·97
29	4·30	4·39	4·49	4·58	4·68	4·79	4·86	4·96	5·05	5·15
30	4·45	4·54	4·64	4·74	4·84	4·95	5·03	5·13	5·23	5·33

TABLE XI C.

VARIATIONS OF GRAVITY WITH LATITUDE AND CORRECTIONS TO BE APPLIED TO STANDARD TEMPERATURES TO DERIVE FIDUCIAL TEMPERATURES.

In Latitudes from 0 to 45, $g < g_{45}$ and the Fiducial Temp. is below the Standard Temp.

In Latitudes from 45 to 90, $g > g_{45}$ and the Fiducial Temp. is above the Standard Temp.

Latitude N. or S.	Variation of Gravity. $\frac{g-g_{45}}{g_{45}}$	Correction to Standard Temperature. Kew.	Correction to Standard Temperature. Fortin.	Latitude N. or S.	Variation of Gravity. $\frac{g-g_{45}}{g_{45}}$	Correction to Standard Temperature. Kew.	Correction to Standard Temperature. Fortin.
Deg.		a.	a.	Deg.		a.	a.
0	−·00259	−15·2	−15·9	45	·00000	0·0	0·0
1	259	15·1	15·9	46	+·00009	+0·5	+0·6
2	258	15·1	15·9	47	·00018	1·1	1·1
3	258	15·1	15·8	48	27	1·6	1·7
4	256	15·0	15·7	49	36	2·1	2·2
5	255	14·9	15·6	50	45	2·6	2·8
6	253	14·8	15·5	51	54	3·1	3·3
7	251	14·7	15·4	52	63	3·7	3·8
8	249	14·6	15·3	53	71	4·2	4·4
9	246	14·4	15·1	54	80	4·7	4·9
10	243	14·2	14·9	55	89	5·2	5·4
11	240	14·0	14·7	56	97	5·7	6·0
12	237	13·8	14·5	57	+·00105	6·2	6·5
13	233	13·6	14·3	58	114	6·6	7·0
14	229	13·4	14·0	59	122	7·1	7·4
15	224	13·1	13·8	60	130	7·6	7·9
16	220	12·8	13·5	61	137	8·0	8·4
17	215	12·5	13·2	62	145	8·5	8·9
18	210	12·3	12·9	63	152	8·9	9·3
19	204	11·9	12·5	64	159	9·3	9·8
20	198	11·6	12·2	65	166	9·7	10·2
21	192	11·3	11·8	66	173	10·1	10·6
22	186	10·9	11·4	67	180	10·5	11·0
23	180	10·5	11·0	68	186	10·9	11·4
24	173	10·1	10·6	69	192	11·3	11·8
25	166	9·7	10·2	70	198	11·6	12·2
26	159	9·3	9·8	71	204	11·9	12·5
27	152	8·9	9·3	72	210	12·3	12·9
28	145	8·5	8·9	73	215	12·5	13·2
29	137	8·0	8·4	74	220	12·8	13·5
30	130	7·6	7·9	75	224	13·1	13·8
31	122	7·1	7·4	76	229	13·4	14·0
32	114	6·6	7·0	77	233	13·6	14·3
33	105	6·2	6·5	78	237	13·8	14·5
34	−·00097	5·7	6·0	79	240	14·0	14·7
35	89	5·2	5·4	80	243	14·2	14·9
36	80	4·7	4·9	81	246	14·4	15·1
37	71	4·2	4·4	82	249	14·6	15·3
38	63	3·7	3·8	83	251	14·7	15·4
39	54	3·1	3·3	84	253	14·8	15·5
40	45	2·6	2·8	85	255	14·9	15·6
41	36	2·1	2·2	86	256	15·0	15·7
42	27	1·6	1·7	87	258	15·1	15·8
43	18	1·1	1·1	88	258	15·1	15·9
44	−·00009	0·5	0·6	89	259	15·1	15·9
45	·00000	−0·0	−0·0	90	+·00259	+15·2	+15·9

TABLE XI D.

Reduction of Pressure to Mean Sea Level.—Heights up to 100 Metres.

Pressure at Station-Level, 1000mb. Corrections to two decimal places. For other pressures the corrections are in proportion.

Height above M.S.L.		Air Temperature.						
		250a. −9° F.	260a. 9° F.	270a. 27° F.	280a. 45° F.	290a. 63° F.	300a. 81° F.	310a. 99° F.
		Corrections in Millibars.						
Feet	Metres.							
7	2	·27	·26	·25	·24	·24	·23	·22
13	4	·55	·53	·51	·49	·47	·46	·44
20	6	·82	·79	·76	·73	·71	·68	·66
26	8	1·09	1·05	1·01	·98	·94	·91	·88
33	10	1·37	1·31	1·27	1·22	1·18	1·14	1·10
39	12	1·64	1·58	1·52	1·46	1·42	1·37	1·32
46	14	1·91	1·84	1·77	1·71	1·65	1·60	1·54
52	16	2·19	2·10	2·03	1·95	1·89	1·82	1·76
59	18	2·46	2·37	2·28	2·20	2·12	2·05	1·99
66	20	2·74	2·63	2·53	2·44	2·36	2·28	2·21
72	22	3·01	2·90	2·79	2·69	2·60	2·51	2·43
79	24	3·28	3·16	3·04	2·93	2·83	2·74	2·65
85	26	3·56	3·42	3·30	3·18	3·07	2·97	2·87
92	28	3·83	3·69	3·55	3·42	3·30	3·19	3·09
98	30	4·11	3·95	3·80	3·67	3·54	3·42	3·31
105	32	4·38	4·21	4·06	3·91	3·78	3·65	3·53
112	34	4·66	4·48	4·31	4·16	4·01	3·88	3·75
118	36	4·93	4·74	4·57	4·40	4·25	4·11	3·98
125	38	5·21	5·01	4·82	4·64	4·49	4·33	4·20
131	40	5·48	5·27	5·07	4·89	4·72	4·57	4·42
138	42	5·76	5·53	5·33	5·14	4·96	4·79	4·64
144	44	6·03	5·80	5·58	5·38	5·20	5·02	4·86
151	46	6·31	6·06	5·84	5·63	5·43	5·25	5·08
157	48	6·58	6·33	6·09	5·87	5·67	5·48	5·30
164	50	6·86	6·59	6·35	6·12	5·91	5·71	5·53
171	52	7·13	6·86	6·60	6·36	6·14	5·94	5·75
177	54	7·41	7·12	6·86	6·61	6·38	6·17	5·[illegible]7
184	56	7·68	7·39	7·11	6·8[illegible]	6·62	6·40	6·19
190	58	7·96	7·65	7·37	7·10	6·86	6·63	6·41
197	60	8·23	7·92	7·62	7·35	7·09	6·86	6·63
203	62	8·51	8·18	7·88	7·59	7·33	7·09	6·86
210	64	8·78	8·45	8·13	7·84	7·57	7·32	7·08
217	66	9·06	8·71	8·39	8·09	7·31	7·54	7·30
223	68	9·34	8·98	8·64	8·33	8·04	7·77	7·52
230	70	9·61	9·24	8·90	8·58	8·28	8·00	7·74
236	72	9·89	9·51	9·15	8·81	8·52	8·23	7·97
243	74	10·16	9·77	9·41	9·07	8·76	8·46	8·19
249	76	10·44	10·04	9·66	9·32	8·99	8·69	8·41
256	78	10·72	10·30	9·92	9·56	9·23	8·92	8·63
262	80	10·99	10·57	10·17	9·81	9·47	9·15	8·86
269	82	11·27	10·84	10·43	10·06	9·71	9·38	9·08
276	84	11·54	11·10	10·69	10·30	9·94	9·61	9·31
282	86	11·82	11·36	10·94	10·55	10·18	9·84	9·52
289	88	12·10	11·63	11·20	10·80	10·42	10·07	9·75
295	90	12·38	11·90	11·45	11·04	10·66	10·30	9·97
302	92	12·65	12·16	11·71	11·29	10·90	10·53	10·19
308	94	12·93	12·43	11·96	11·54	11·14	10·76	10·41
316	96	13·21	12·69	12·22	11·78	11·37	10·99	10·64
322	98	13·48	12·96	12·48	12·03	11·61	11·22	10·86
325	100	13·76	13·23	12·73	12·28	11·85	11·45	11·08

TABLE XI E.

Reduction of Pressure in Millibars to Mean Sea Level.

Pressure at Station Level, 950 Millibars. Corrections to one decimal place.

Height in Feet.	Height in Metres.	Air Temperature. 250a. −9° F.	260a. 9° F.	270a. 27° F.	280a. 45° F.	290a. 63° F.	300a. 81° F.	310a. 99° F.
		Millibars						
33	10	1·3	1·2	1·2	1·1	1·1	1·0	1·0
66	20	2·6	2·5	2·4	2·3	2·3	2·2	2·1
98	30	3·9	3·8	3·6	3·5	3·3	3·2	3·1
131	40	5·2	5·0	4·8	4·7	4·5	4·4	4·2
164	50	6·6	6·3	6·1	5·8	5·6	5·4	5·2
197	60	7·9	7·5	7·2	7·0	6·7	6·6	6·3
230	70	9·1	8·8	8·5	8·2	7·9	7·6	7·4
262	80	10·5	10·1	9·7	9·3	9·0	8·7	8·5
295	90	11·8	11·3	10·9	10·5	10·2	9·8	9·5
328	100	13·1	12·6	12·2	11·7	11·3	10·9	10·5
361	110	14·4	13·9	13·3	12·8	12·4	12·0	11·6
394	120	15·7	15·1	14·5	14·1	13·6	13·1	12·6
427	130	17·0	16·3	15·8	15·2	14·7	14·2	13·8
459	140	18·3	17·7	17·0	16·3	15·8	15·3	14·8
492	150	19·7	18·9	18·2	17·6	16·9	16·3	15·9
525	160	21·0	20·1	19·4	18·7	18·1	17·5	16·9
558	170	22·3	21·5	20·6	19·9	19·2	18·6	18·0
591	180	23·7	22·7	21·9	21·1	20·3	19·7	19·0
623	190	25·0	23·9	23·1	22·2	21·5	20·8	20·1
656	200	26·3	25·3	24·3	23·5	22·6	21·9	21·2
689	210	27·6	26·5	25·6	24·6	23·8	23·0	22·2
722	220	29·0	27·8	26·8	25·8	24·9	24·0	23·3
755	230	30·3	29·2	28·0	27·0	26·0	25·2	24·3
787	240	31·6	30·4	29·3	28·2	27·2	26·3	25·5
820	250	33·0	31·7	30·5	29·4	28·3	27·4	26·5
853	260	34·4	33·0	31·7	30·6	29·5	28·5	27·6
886	270	35·7	34·3	33·0	31·8	30·7	29·6	28·6
919	280	37·1	35·6	34·2	33·0	31·8	30·8	29·7
951	290	38·4	36·9	35·5	34·2	33·0	31·8	30·8
984	300	39·7	38·2	36·8	35·4	34·1	33·0	31·9
1,017	310	41·0	39·4	38·0	36·6	35·3	34·1	33·0
1,050	320	42·5	40·8	39·2	37·8	36·5	35·2	34·1
1,083	330	43·8	42·1	40·5	39·0	37·6	36·4	35·2
1,116	340	45·1	43·3	41·7	40·2	38·8	37·4	36·2
1,148	350	46·5	44·7	42·9	41·4	40·0	38·6	37·3
1,181	360	47·9	46·0	44·3	42·7	41·1	39·7	38·4
1,214	370	49·2	47·2	45·5	43·8	42·3	40·9	39·5
1,247	380	50·5	48·5	46·7	45·0	43·4	42·0	40·6
1,280	390	52·0	49·9	48·0	46·3	44·7	43·1	41·7
1,312	400	53·3	51·2	49·2	47·4	45·8	44·3	42·8
1,345	410	54·7	52·5	50·5	48·6	46·9	45·4	43·9
1,378	420	56·1	53·9	51·8	49·9	48·2	46·5	44·9
1,411	430	57·5	55·2	53·0	51·1	49·3	47·6	46·1
1,444	440	58·8	56·5	54·3	52·3	50·4	48·7	47·1
1,476	450	60·2	57·9	55·6	53·6	51·7	49·9	48·3
1,509	460	61·6	59·2	56·9	54·8	52·8	51·0	49·3
1,542	470	63·0	60·4	58·1	56·0	54·0	52·2	50·4
1,575	480	64·3	61·8	59·5	57·2	55·2	53·3	51·5
1,608	490	65·7	63·1	60·7	58·4	56·3	54·4	52·6
1,640	500	67·1	64·4	62·0	59·7	57·6	55·6	53·8

TABLE XI E—*continued*.

REDUCTION OF PRESSURE IN MILLIBARS TO MEAN SEA LEVEL.

Pressure at Station Level, 1,000 Millibars. Corrections to one decimal place.

For other pressures the corrections are in proportion.

Height in Feet.	Height in Metres.	Air Temperature. 250a. −9° F.	260a. 9° F.	270a. 27° F.	280a. 45° F.	290a. 63° F.	300a. 81° F.	310a. 99° F.
		Millibars.						
33	10	1·4	1·3	1·3	1·2	1·2	1·1	1·1
66	20	2·7	2·6	2·5	2·4	2·4	2·3	2·2
98	30	4·1	4·0	3·8	3·7	3·5	3·4	3·3
131	40	5·5	5·3	5·1	4·9	4·7	4·6	4·4
164	50	6·9	6·6	6·4	6·1	5·9	5·7	5·5
197	60	8·2	7·9	7·6	7·4	7·1	6·9	6·6
230	70	9·6	9·2	8·9	8·6	8·3	8·0	7·7
262	80	11·0	10·6	10·2	9·8	9·5	9·2	8·9
295	90	12·4	11·9	11·5	11·1	10·7	10·3	10·0
328	100	13·8	13·2	12·7	12·3	11·9	11·5	11·1
361	110	15·2	14·6	14·0	13·5	13·1	12·6	12·2
394	120	16·5	15·9	15·3	14·8	14·3	13·8	13·3
427	130	17·9	17·2	16·6	16·0	15·5	14·9	14·5
459	140	19·3	18·6	17·9	17·2	16·6	16·1	15·6
492	150	20·7	19·9	19·2	18·5	17·8	17·2	16·7
525	160	22·1	21·2	20·4	19·7	19·0	18·4	17·8
558	170	23·5	22·6	21·7	20·9	20·2	19·6	18·9
591	180	24·9	23·9	23·0	22·2	21·4	20·7	20·0
623	190	26·3	25·2	24·3	23·4	22·6	21·9	21·2
656	200	27·7	26·6	25·6	24·7	23·8	23·0	22·3
689	210	29·1	27·9	26·9	25·9	25·0	24·2	23·4
722	220	30·5	29·3	28·2	27·2	26·2	25·3	24·5
755	230	31·9	30·7	29·5	28·4	27·4	26·5	25·6
787	240	33·3	32·0	30·8	29·7	28·6	27·7	26·8
820	250	34·7	33·4	32·1	30·9	29·8	28·8	27·9
853	260	36·2	34·7	33·4	32·2	31·1	30·0	29·0
886	270	37·6	36·1	34·7	33·5	32·3	31·2	30·1
919	280	39·0	37·5	36·0	34·7	33·5	32·4	31·3
951	290	40·4	38·8	37·4	36·0	34·7	33·5	32·4
984	300	41·8	40·2	38·7	37·3	35·9	34·7	33·6
1,017	310	43·2	41·5	40·0	38·5	37·2	35·9	34·7
1,050	320	44·7	42·9	41·3	39·8	38·4	37·1	35·9
1,083	330	46·1	44·3	42·6	41·1	39·6	38·3	37·0
1,116	340	47·5	45·6	43·9	42·3	40·8	39·4	38·1
1,148	350	48·9	47·0	45·2	43·6	42·1	40·6	39·3
1,181	360	50·4	48·4	46·6	44·9	43·3	41·8	40·4
1,214	370	51·8	49·7	47·9	46·1	44·5	43·0	41·6
1,247	380	53·2	51·1	49·2	47·4	45·7	44·2	42·7
1,280	390	54·7	52·5	50·5	48·7	47·0	45·4	43·9
1,312	400	56·1	53·9	51·8	49·9	48·2	46·6	45·0
1,345	410	57·6	55·3	53·2	51·2	49·4	47·8	46·2
1,378	420	59·0	56·7	54·5	52·5	50·7	48·9	47·3
1,411	430	60·5	58·1	55·8	53·8	51·9	50·1	48·5
1,444	440	61·9	59·5	57·2	55·1	53·1	51·3	49·6
1,476	450	63·4	60·9	58·5	56·4	54·4	52·5	50·8
1,509	460	64·8	62·3	59·9	57·7	55·6	53·7	51·9
1,542	470	66·3	63·6	61·2	58·9	56·8	54·9	53·0
1,575	480	67·7	65·0	62·6	60·2	58·1	56·1	54·2
1,608	490	69·2	66·4	63·9	61·5	59·3	57·3	55·4
1,640	500	70·6	67·8	65·3	62·8	60·6	58·5	56·6

TABLE XI E—*continued.*

Reduction of Pressure in Millibars to Mean Sea Level.

Pressure at Station Level, 1,050 Millibars. Corrections to one decimal place.

Height in Feet.	Height in Metres.	Air Temperature. 250a. −9° F.	260a. 9° F.	270a. 27° F.	280a. 45° F.	290a. 63° F.	300a. 81° F.	310a. 99° F.
		Millibars.						
33	10	1·5	1·4	1·4	1·3	1·3	1·2	1·2
66	20	2·8	2·7	2·6	2·5	2·5	2·4	2·3
98	30	4·3	4·2	4·0	3·9	3·7	3·6	3·5
131	40	5·8	5·6	5·4	5·1	4·9	4·8	4·6
164	50	7·2	6·9	6·7	6·4	6·2	6·0	5·8
197	60	8·7	8·3	8·0	7·8	7·5	7·2	6·9
230	70	10·1	9·8	9·3	9·0	8·7	8·4	8·2
262	80	11·6	11·1	10·7	10·3	10·0	9·7	9·3
295	90	13·0	12·5	12·1	11·7	11·2	10·8	10·5
328	100	14·5	14·0	13·4	12·9	12·5	12·1	11·7
361	110	16·0	15·3	14·7	14·2	13·8	13·2	12·8
394	120	17·3	16·7	16·1	15·5	15·0	14·5	14·0
427	130	18·8	18·1	17·4	16·8	16·3	15·6	15·2
459	140	20·3	19·5	18·8	18·1	17·4	16·9	16·4
492	150	21·7	20·9	20·2	19·4	18·7	18·1	17·5
525	160	23·2	22·3	21·4	20·7	20·0	19·3	18·7
558	170	24·7	23·7	22·8	21·9	21·2	20·6	19·8
591	180	26·1	25·1	24·2	23·3	22·5	21·7	21·0
623	190	27·6	26·5	25·5	24·6	23·7	23·0	22·3
656	200	29·1	27·9	26·9	25·9	25·0	24·2	23·4
689	210	30·6	29·4	28·2	27·2	26·3	25·4	24·6
722	220	32·0	30·8	29·6	28·6	27·5	26·6	25·7
755	230	33·5	32·2	31·0	29·8	28·8	27·8	26·9
787	240	35·0	33·6	32·3	31·2	30·0	29·1	28·1
820	250	36·4	35·1	33·7	32·4	31·3	30·2	29·3
853	260	38·0	36·4	35·1	33·8	32·7	31·5	30·5
886	270	39·5	37·9	36·4	35·2	33·9	32·8	31·6
919	280	41·0	39·4	37·8	36·4	35·2	34·0	32·9
951	290	42·4	40·7	39·3	37·8	36·4	35·2	34·0
984	300	43·9	42·2	40·6	39·2	37·7	36·4	35·3
1,017	310	45·4	43·5	42·0	40·4	39·1	37·7	36·4
1,050	320	46·9	45·0	43·4	41·8	40·3	39·0	37·7
1,083	330	48·4	46·5	44·7	43·2	41·6	40·2	38·9
1,116	340	49·9	47·9	46·1	44·4	42·8	41·4	40·0
1,148	350	51·3	49·4	47·5	45·8	44·2	42·6	41·3
1,181	360	52·9	50·8	48·9	47·1	45·5	43·9	42·4
1,214	370	54·4	52·2	50·3	48·4	46·7	45·2	43·7
1,247	380	55·9	53·7	51·7	49·8	48·0	46·4	44·8
1,280	390	57·4	55·1	53·0	51·1	49·4	47·7	46·1
1,312	400	58·9	56·6	54·4	52·4	50·6	48·9	47·3
1,345	410	60·5	58·1	55·9	53·8	51·9	50·2	48·5
1,378	420	32·0	59·5	57·2	55·1	53·2	51·3	49·7
1,411	430	63·5	61·0	58·6	56·5	54·5	52·6	50·9
1,444	440	65·0	62·5	60·1	57·9	55·8	53·9	52·1
1,476	450	66·6	63·9	61·4	59·2	57·1	55·1	53·3
1,509	460	68·0	65·4	62·9	60·6	58·4	56·4	54·5
1,542	470	69·6	66·8	64·3	61·8	59·6	57·6	55·8
1,575	480	71·1	68·3	65·7	63·2	61·0	58·9	56·9
1,608	490	72·7	69·7	67·1	64·6	62·3	60·2	58·2
1,640	500	74·1	71·2	68·6	65·9	63·6	61·4	59·4

INDEX.

A

B

C

C—*continued.*

D

E

F

G

H

I

K

L

M

N

O

P

R

S

S—*continued.*

T

V

W

Z

By Authority: H. J. Green, Government Printer, Melbourne.

Commonwealth Meteorological Bureau,
Box 1289K, General Post Office,
Melbourne.
31st May, 1933.

Memorandum to Meteorological Observers at stations in the Commonwealth from which daily telegraphic reports are sent to "Weather," Perth, Adelaide, Brisbane, Sydney, Melbourne, or Hobart.

These codes are to be used on and after 1st October, 1933. Please place them in your Handbook or on Sheet for use in place of codes previously issued.

W. S. WATT,
Commonwealth Meteorologist.

C.4890.

X

BAROMETER CODE.

Bar.	Code Word.	Bar.	Code Word.	Bar.	Code Word.	Bar.	Code Word.
Inches.		Inches.		Inches.		Inches.	
29.00	Fataz	29.45	Fesso	29.90	Fitfu	30.35	Forwa
29.01	Fated	29.46	Festu	29.91	Fixed	30.36	Fraga
29.02	Fath	29.47	Fetch	29.92	Flag Fla	30.37	Fraud
29.03	Fatho	29.48	Fetid	29.93	Flago	30.38	Fraz
29.04	Fatig	29.49	Feuda	29.94	Flail	30.39	Freak
29.05	Fatly	29.50	Fever	29.95	Flake	30.40	Freck
29.06	Faudy	29.51	Few	29.96	Flap	30.41	Freem
29.07	Faugh	29.52	Fezzo	29.97	Flars	30.42	Fremo
29.08	Fault	29.53	Fiat Fi	29.98	Flaxy	30.43	Fren
29.09	Fauna	29.54	Fibri	29.99	Fled Fle	30.44	Frenz
29.10	Faust	29.55	Ficka	30.00	Flee	30.45	Fresk
29.11	Favor	29.56	Fidax	30.01	Fleet	30.46	Friar
29.12	Fawn	29.57	Fidca	30.02	Flesh	30.47	Frict
29.13	Fay	29.58	Fido	30.03	Flex	30.48	Fride
29.14	Fayal	29.59	Fidus	30.04	Fling Fli	30.49	Frifa
29.15	Fayet	29.60	Fiend	30.05	Flipp Flo	30.50	Frigo
29.16	Feaky	29.61	Fiery	30.06	Flock	30.51	Frill
29.17	Fear	29.62	Fife Fif	30.07	Flor	30.52	Frina
29.18	Fearo	29.63	Fifth	30.08	Floss	30.53	Frio
29.19	Feast	29.64	Fifty	30.09	Flown	30.54	Frit
29.20	Feata	29.65	Fight	30.10	Flue Flu	30.55	Frogg
29.21	Feax	29.66	Figma	30.11	Fluid	30.56	Froli
29.22	Fecor	29.67	Figur	30.12	Flury	30.57	Front
29.23	Feder	29.68	Filb Fil	30.13	Flute	30.58	Froth
29.24	Feeba	29.69	Filch	30.14	Foamy Foa	30.59	Frown
29.25	Feed	29.70	Filia	30.15	Focal	30.60	Froze
29.26	Feedy	29.71	Filig	30.16	Focus	30.61	Fruga
29.27	Fefto	29.72	Filju	30.17	Foist	30.62	Fudge
29.28	Felix	29.73	Fill	30.18	Folio Fol	30.63	Fuel
29.29	Felon	29.74	Film	30.19	Folks	30.64	Fugit
29.30	Felsy	29.75	Fimpa	30.20	Fond	30.65	Fugue
29.31	Femal	29.76	Finan FIN	30.21	Food	30.66	Fulca
29.32	Fence	29.77	Finch	30.22	Fopp	30.67	Fulfi
29.33	Fenia	29.78	Findy	30.23	Foray FOR	30.68	Full
29.34	Fenno	29.79	Finex	30.24	Forb	30.69	Fully
29.35	Fenty	29.80	Finfo	30.25	Forex	30.70	Fulma
29.36	Ferm	29.81	Finga	30.26	Forfy	30.71	Fulso
29.37	Ferni	29.82	Finis	30.27	Forg	30.72	Furze
29.38	Ferot	29.83	Finky	30.28	Forgo	30.73	Fuss
29.39	Ferpo	29.84	Finn	30.29	Forla	30.74	Fusto
29.40	Ferru	29.85	Finny	30.30	Form		
29.41	Ferry	29.86	Fiola Fio	30.31	Formy		
29.42	Ferta	29.87	Fisca FIS	30.32	Forth		
29.43	Fesab	29.88	Fish	30.33	Fortu		
29.44	Fesik	29.89	Fit	30.34	Forum		

If the barometer reading does not fall within the range of the above table, the complete reading should be sent in figures, e.g., 28.32.

TEMPERATURE CODE.

Temp.	Code Word.	Temp.	Code Word.	Temp.	Code Word.	Temp.	Code Word.	Temp.	Code Word.
° F.		° F.		° F.		° F.		° F.	
0	Thaw	25	Tidy	50	Tory	75	Trib	100	Turf
1	That	26	Tiff	51	Total	76	Tribu	101	Turgi
2	Thebe	27	Tiger	52	Touch	77	Trick	102	Turka
3	Thee	28	Time	53	Toulo	78	Trig	103	Turn
4	Theft	29	Tinda	54	Towel	79	Trill	104	Turps
5	Then	30	Ting	55	Town	80	Trio	105	Tursy
6	There	31	Tinky	56	Trace	81	Tripa	106	Tusca
7	Therm	32	Tins	57	Trade	82	Trizy	107	Tusk
8	Thesi	33	Tioga	58	Trady	83	Troph	108	Tutor
9	They	34	Tip	59	Traff	84	Truan	109	Twain
10	Thib	35	Tipto	60	Tragi	85	True	110	Twent
11	Thick	36	Titan	61	Train	86	Truly	111	Twine
12	Thief	37	Tivol	62	Trako	87	Trum	112	Twirl
13	Think	38	Toddy	63	Traja	88	Trust	113	Twist
14	Thom	39	Toff	64	Trank	89	Truth	114	Twixo
15	Thope	40	Toil	65	Trash	90	Try	115	Tybec
16	Thras	41	Token	66	Trawl	91	Tubby	116	Tycoo
17	Threl	42	Told	67	Tray	92	Tuft	117	Tyler
18	Throb	43	Tomb	68	Treat	93	Tug	118	Tymba
19	Thron	44	Tone	69	Treb	94	Tumba	119	Type
20	Throw	45	Tonic	70	Tree	95	Tump	120	Typic
21	Thrum	46	Top	71	Trend	96	Tunis	121	Tyran
22	Thyme	47	Topek	72	Trepa	97	Tunn	122	Tyres
23	Tick	48	Topio	73	Tresp	98	Tura	123	Tyro
24	Tide	49	Torp	74	Trial	99	Turbi	124	Tyrol

WIND CODE.

Direction.	Code Word.	Force.	Description.	Miles per Hour.
N.	Race	1	Light air	2
N.N.E.	Rack	2	Slight breeze	5
N.E.	Rady	3	Gentle breeze	10
E.N.E.	Radix	4	Moderate breeze	15
E.	Rag	5	Fresh breeze	21
E.S.E.	Raise	6	Strong breeze	27
S.E.	Rally	7	High wind	35
S.S.E.	Ramp	8	Gale	42
S.	Ranch	9	Strong gale	50
S.S.W.	Ranso	10	Whole gale	59
S.W.	Rank	11	Storm	68
W.S.W.	Rapid	12	Hurricane	Above 75
W.	Rare			
W.N.W.	Rasca			
N.W.	Ratta			
N.N.W.	Razor			
Calm	Reap			

The number for the force of the wind should be written in full after the code word for the direction, e.g., N.W. 6 should be sent as "Ratta six."

RAINFALL CODE.

Points.	Code Word.	Points.	Code Word.	Points.	Code Word.	Points.	Code Word.
0	Ab	30	Agate	60	Alum	90	April
1	Abase	31	Agbol	61	Amass	91	Apron
2	Abbot	32	Aged	62	Amaze	92	Aqua
3	Abet	33	Agent	63	Amber	93	Arab
4	Abide	34	Agile	64	Amble	94	Arcad
5	Able	35	Aglow	65	Amen	95	Arch
6	Absen	36	Ague	66	Amid	96	Ardex
7	Abyss	37	Ahead	67	Amiss	97	Ardor
8	Ache	38	Aid	68	Ammon	98	Argo
9	Acme	39	Ajar	69	Ample	99	Argus
10	Act	40	Akin	70	Amula	100	Babel
11	Activ	41	Alas	71	Andy	200	Balm
12	Actor	42	Alba	72	Angel	300	Barge
13	Acute	43	Album	73	Angry	400	Bask
14	Adapt	44	Alcov	74	Anise	500	Bay
15	Aden	45	Alert	75	Ankle	600	Beard
16	Adieu	46	Alibi	76	Annex	700	Beat
17	Adler	47	Alike	77	Annoy	800	Belch
18	Admit	48	Allan	78	Annul	900	Bell
19	Adorn	49	Alleg	79	Antho	1,000	Benga
20	Adri	50	Allud	80	Antic	1,100	Bind
21	Adrif	51	Alma	81	Anvil	1,200	Blame
22	Adult	52	Alms	82	Any	1,300	Bled
23	Advis	53	Aloe	83	Apart	1,400	Bligh
24	Afar	54	Aloft	84	Ape	1,500	Bloom
25	Affix	55	Along	85	Apex	1,600	Blush
26	Afray	56	Aloud	86	Apish	1,700	Body
27	Afrit	57	Alpha	87	Appea	1,800	Bold
28	Afron	58	Alps	88	Appso	1,900	Brace
29	Again	59	Also	89	Apply	2,000	Brute

If the rain exceeds 100 points, it is to be sent in two words; for instance, 281 points is to be telegraphed as "Balm Anvil."

When rains have fallen in country districts, particularly when moderate amounts only have been recorded, the effect of the rain will depend on the way in which it has fallen. If, for instance, the fall has been rapid, even so small an amount as 10 points may cause a considerable run-off into streams, tanks, or dams, and thus provide valuable supplies for watering stock. On the other hand, 50 points or more falling as a light rain spread over a large part of a day may cause practically no run-off. In the latter case there would be no important addition to water storages, but the growth of feed may be maintained for a further period or the wheat yield be considerably increased. Business men are consequently anxious to have some indication of the nature of the rainfall telegraphed, as well as its amount.

Country observers are, therefore, requested, whenever they think that they can usefully do so, to classify rainfall in their telegraphic reports as Pastoral, Tank, or Pastoral and Tank, by inserting after the amount the letters P, T, or PT respectively. In some cases the rains, though heavy, may be in the form of isolated showers which may fill storage basins but not be sufficiently general to be of much value for producing feed.

A certain number of observers have been requested to send a special telegram at 6 p.m. reporting the amount of rainfall between 9 a.m. and 6 p.m. on days when any rain has fallen. These observers are reminded of the request and urged to send their reports regularly.

The total rainfall for each month is to be telegraphed on the last day of the month. For example if a total of 476 points has been recorded, the words "Month bask annex" are to be either included in the telegram for the day, or sent per separate telegram.

WEATHER CODE.

	Code Word.	Description.
Without Precipitation.	Sabre ..	Clear, i.e., sky less than 2 tenths clouded
	Sacks ..	Quarter clouded, i.e., sky 2 to 3 tenths clouded
	Sad ..	Half clouded, i.e., sky 4 to 6 tenths clouded
	Sadly ..	Three-quarter clouded, i.e., sky 7 to 8 tenths clouded, but clouds chiefly high (Cirrus or Alto clouds)
	Safe ..	Three-quarter clouded, i.e., sky 7 to 8 tenths clouded, but clouds chiefly low (Cumulus, Strato-Cumulus, &c.)
	Sago ..	Overcast, i.e., sky 9 to 10 tenths clouded, but clouds chiefly high
	Salad ..	Overcast, i.e., sky 9 to 10 tenths clouded, but clouds chiefly low
	Salon ..	Overcast and dull or threatening
	Salt ..	Sky not overcast at station, but conditions threatening in........ (here give direction in letters, e.g., N.W.)
	Salvo ..	Distant lightning seen to............(add direction as above)
	Sambo ..	Thunder, or thunder and lightning, but no rain
With Precipitation.	Sand ..	Misty rain
	Sappy ..	Light rain or drizzle
	Sara ..	Steady rain
	Satan ..	Heavy, steady rain
	Save ..	Passing showers
	Scalp ..	Frequent showers
	Scant ..	Heavy showers
	Scoop ..	Snow or snow and rain
	Score ..	Hail or hail and rain
	Scull ..	Raining, with lightning visible in distance
	Sear ..	Thunderstorm, with light rain
	Sect ..	,, with heavy rain
	Seize ..	,, with hail or hail and rain
	SCOPE	SNOW REMAINING ON GROUND
Winds.	Semi ..	Squally
	Sepia ..	Heavy squalls
	Serio ..	Wind force increasing
	Septi ..	Wind force decreasing
	Sex ..	Hot wind
	Shin ..	Cool change
	Shiny ..	Line squall
Atmosphere.	Side ..	Smoke haze
	Sink ..	Haze
	Sirup ..	Mist
	Slam ..	Thin fog
	Slice ..	Fog of moderate intensity (visibility less than 1½ miles)
	Slip ..	Dense fog (visibility less than 220 yards)
	Sly ..	Dust storm
	Sock ..	Sultry
Miscel-laneous	Song ..	Heavy dew this morning
	Star ..	Hoar frost this morning
	Stun ..	Since previous report

More than one code word should be used if necessary. The following are examples :—

Sadly serio stun salvo N.W. = Sky three-quarter clouded, but clouds chiefly high; wind force increasing; lightning seen to the north-west since last report

Sabre star = Clear; hoar frost this morning

Semi scant scull = Squally, with heavy showers; lightning visible in distance

CLOUD CODE.

Clouds Moving from—		Upper Clouds. Cirrus, Cirro-Stratus, and Cirro-Cumulus.	Middle. Alto-Cumulus, Alto-Stratus.	Lower. Cumulus, Strato-Cumulus, &c.
N.	360	Loam	Leaf	Lace
N.N.E.	22½	Lobby	Leag	Lack
N.E.	45	Local	Leak	Lady
E.N.E.	67½	Lock	Learn	Lag
E.	90	Lodge	Lease	Lago
E.S.E.	112½	Lofty	Ledge	Lamp
S.E.	135	Loin	Left	Lance
S.S.E.	157½	Long	Leg	Lapel
S.	180	Lop	Lega	Lard
S. by W.	191¼	Loper	Legan	
S.S.W.	202½	Lord	Legex	Largo
S.W. by S.	213¾	Lormy	Legio	
S.W.	225	Lorry	Lemon	Lark
S.W. by W.	236¼	Loser	Lend	
W.S.W.	247½	Loss	Lento	Lash
W. by S.	258¾	Loth	Lents	
W.	270	Loud	Leo	Latin
W. by N.	281¼	Loufo	Leona	
W.N.W.	292½	Love	Less	Launo
N.W. by W.	303¾	Low	Lesso	
N.W.	315	Lowly	Letta	Lava
N.W. by N.	326¼	Lowso	Leura	
N.N.W.	337½	Loyal	Level	Lawn
N. by W.	348¾	Loyo	Levy	

The directions in the second column are given from north round by east through 360 degrees.

CODE FOR SEA DISTURBANCE.

Scale Number.	Description.	Code Word.	Scale Number.	Description.	Code Word.
	Sea Rising	Nabob	4	Moderate	Nice
	Sea Moderating	Nadir	5	Rather Rough	Nose
0	Calm	Nag	6	Rough	Not
1	Very Smooth	Neck	7	High	Noun
2	Smooth	Need	8	Very High	Novel
3	Slight	Nest	9	Phenomenal	Nude

Two words may be used if necessary, e.g., Nose nabob = sea rather rough and rising.

By Authority: H. J. Green, Government Printer, Melbourne.